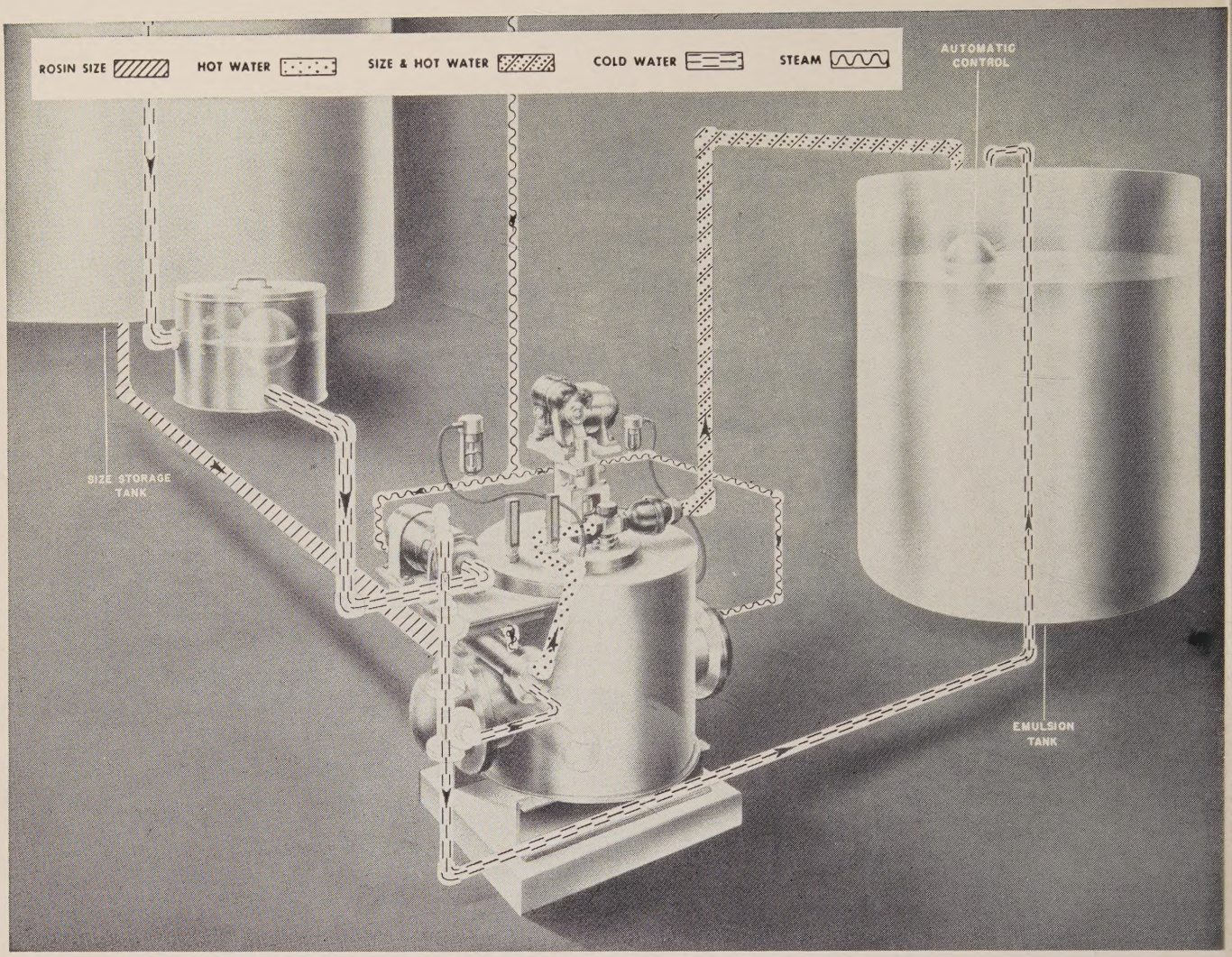
Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

JULY 1953



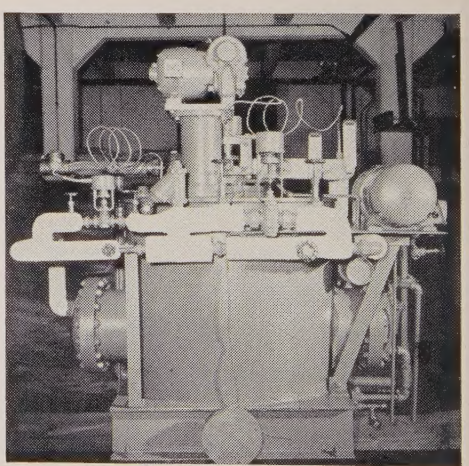
This drawing depicts the Hercules Automatic Emulsifying Process in operation, and traces the flow of rosin size, hot water, cold water, and steam to the final rosin size emulsion.

HERCULES AUTOMATIC EMULSIFIERS CUT SIZING COSTS IN OVER 60 MILLS

A steadily increasing number of paper and board mills are reducing labor costs and space requirements, while getting better uniformity in their size emulsions, with the Hercules Automatic Emulsifying Process—introduced by Hercules in 1948.

Latest figures show that more than 60 Hercules Automatic Emulsifiers are now in daily operation, and many others are being installed or on order. This represents an overwhelming majority of the total number of all automatic emulsifiers in the paper industry.

For further details, write for technical booklet.



Occupying a space of only 6 ft. by 6 ft., this Hercules Automatic Emulsifier can be conveniently placed in most paper mills.

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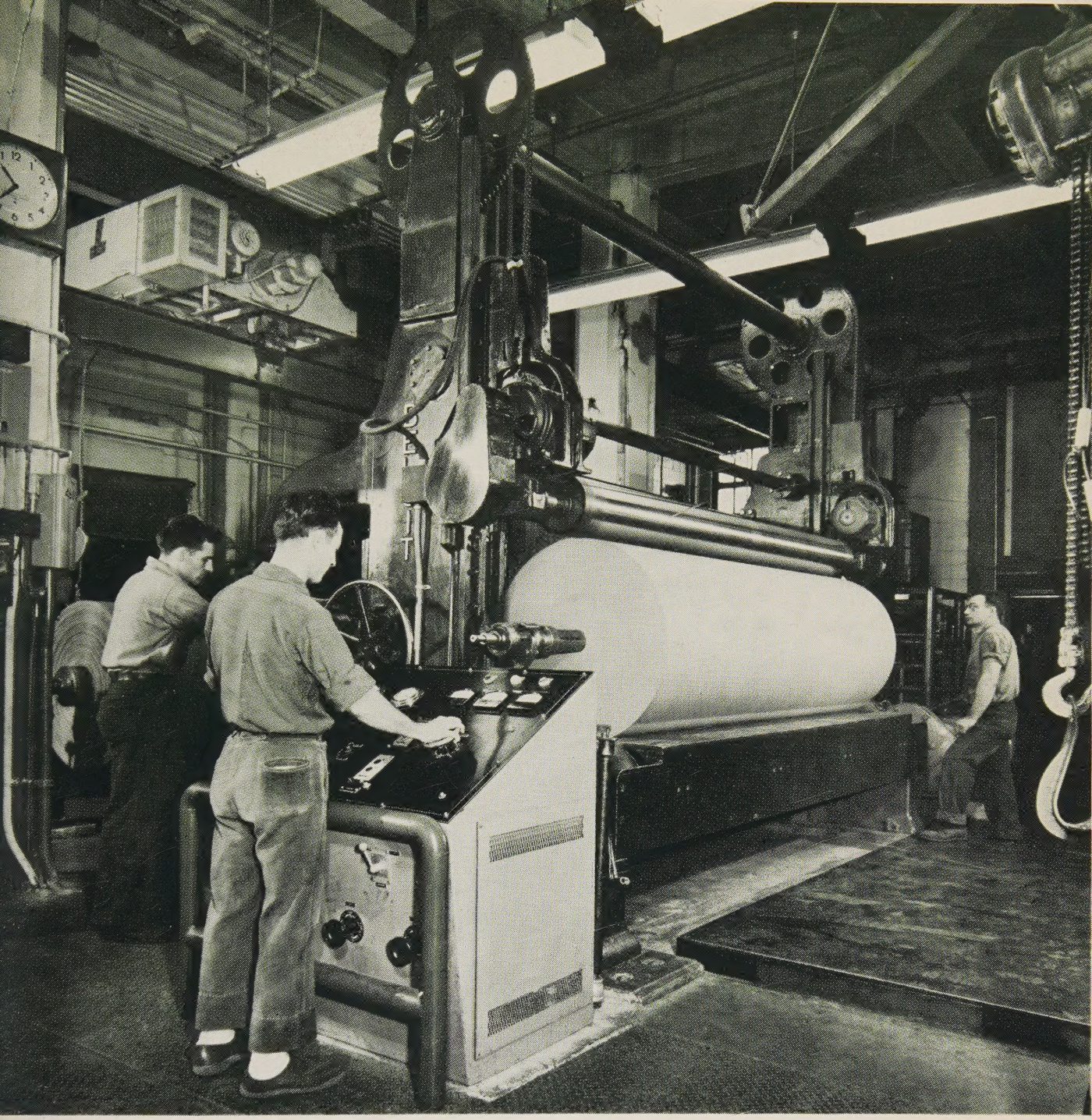
SIZING MATERIALS AND CHEMICALS FOR PAPER

PP53-4



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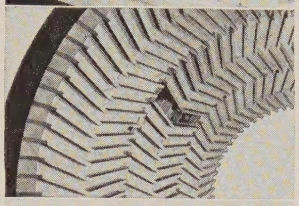

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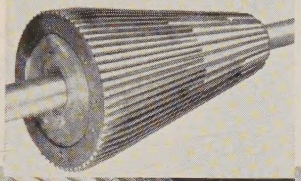
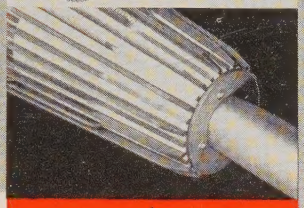
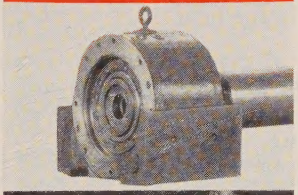




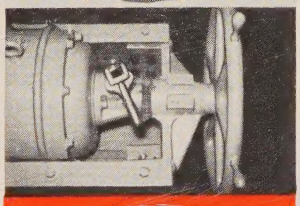
Same plug slots take various filling sizes

Plug shaft positively centered



Sleeve mounted Timken bearings for easy removal

Precision plug adjustment for longer filling wear



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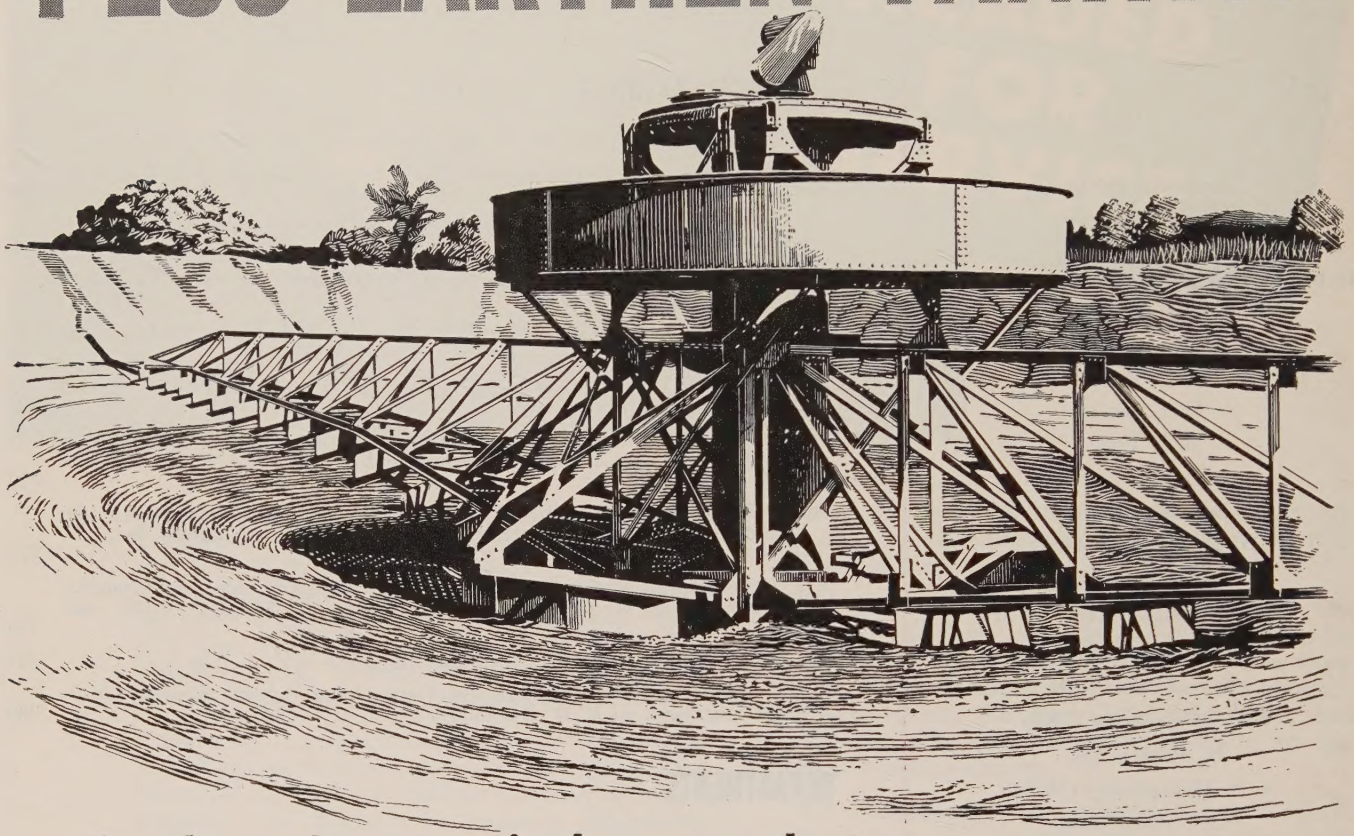

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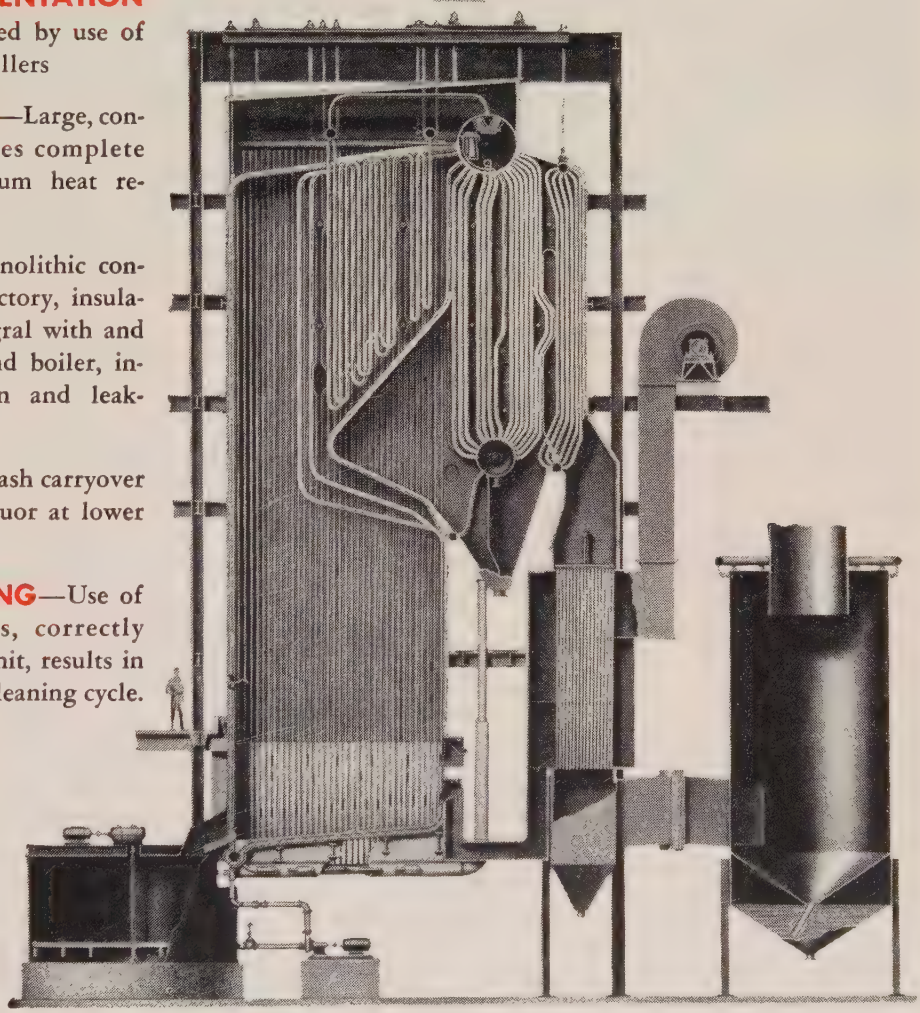

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for

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of adhesive in corrugated paperboard

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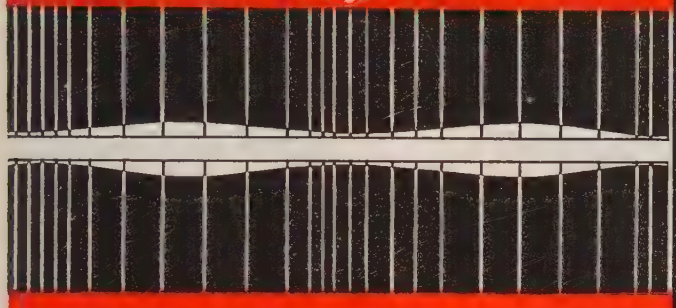
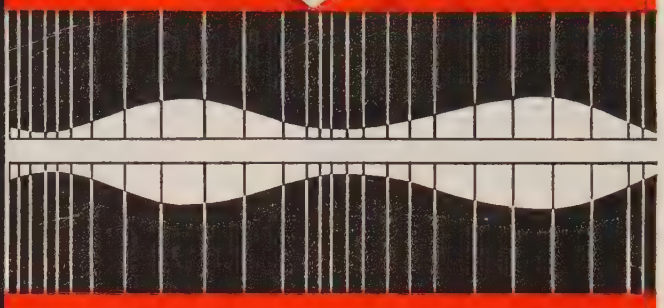


Controlled Penetration with KELSIZE

Here — you can see how penetration of adhesive is controlled, regardless of variation in paperboard porosity, through the use of a fraction of a per cent of Kelsize added to the adhesive.

NOT THIS



Uncontrolled Penetration

Note that where penetration of adhesive is uncontrolled, the variation of penetration is in proportion to the variation in porosity of the paperboard.

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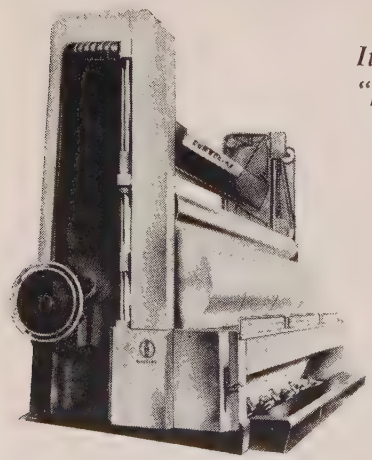

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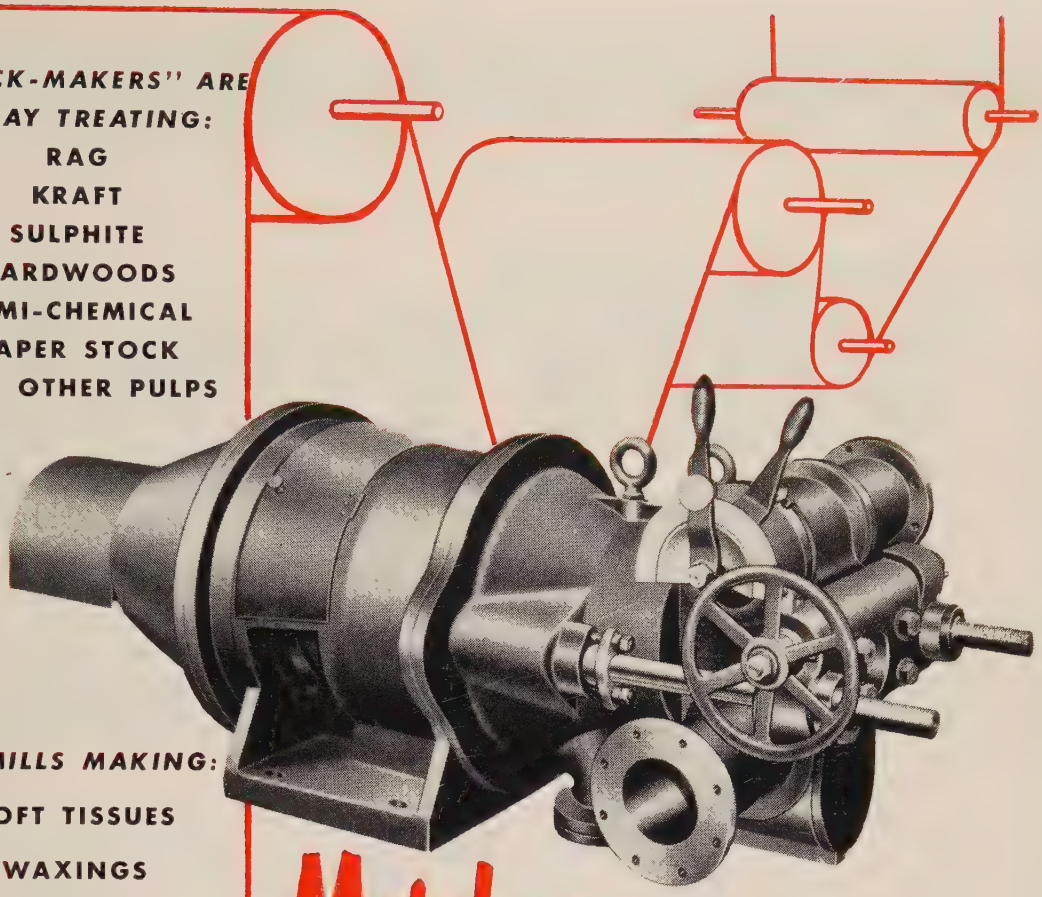

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METHODS FOR ESTIMATING CONSTRUCTION COSTS*

New Cost Data—Field-Erected Storage Tanks

FRED L. PLUMMER

Publication of the following article has been arranged by the TAPPI committee investigating "Methods for Estimating Construction Costs." The article was published in *Chemical Engineering Costs Quarterly*, July, 1952, O. T. Zimmerman and Irvin Lavine, Editors, Industrial Research Service, Dover, N. H. The storage of fluid is often a major problem in the process industries and the cost of storage facilities frequently represents a rather large portion of the capital investment. The author describes several types of storage tanks and presents charts showing installed costs, including the cost of materials, fabrication, and erection of the tanks assuming average values for transportation, field labor, insurance, and tax costs and based on rates in effect during the first quarter of 1952.

In the chemical process industry, the storage of fluids is often a major problem, and the cost of storage facilities frequently represents a rather large portion of the capital investment. For example, a 10,000-barrel tank costs in the order of $10,000 to $20,000 depending upon the type of tank required.

A number of types of field-erected storage tanks are available, and the selection of a particular type depends upon the properties of the fluid to be stored and the storage conditions. The types discussed here are as follows:

A. *Fixed Volume Steel Tanks*
   1. Cylindrical, flat-bottom, cone or dome-roof tanks:
      (a) For storage of noncorrosive liquids lighter than water.
      (b) For storage of water.
      (c) For storage of corrosive liquids and those heavier than water.
      (d) For storage of volatile liquids.
   2. Spheres, bullets, and special shape tanks.
   3. Underground tanks.
   4. Elevated water tanks.

B. *Variable Volume Steel Tanks*
   1. Tanks with floating roofs.
   2. Tanks with lifter roofs.
   3. Tanks with diaphragms:
      (a) Hammond Dialift tanks.
      (b) Hammond Diaflote tanks.

COSTS

The total initial cost of field-erected storage tanks must cover at least the following items:

1. Preparation of the foundation.
2. Material for, and fabrication and erection of the tank itself.
3. Fittings and auxiliary equipment.
4. Painting and special protective coatings.

For certain services, designs of storage tanks are governed by widely accepted codes and have been quite generally standardized. For some services, however, customer requirements vary widely and it is not possible to predict costs without considering the specific service requirements. In general, material, fabricating, and erection costs can be estimated very accurately; however, some costs depend upon the location of the proposed installation. Transportation costs for material, erection equipment, and crew will obviously depend upon the site location. For example, wage rates for members of the erection crew vary as much as 30% for different localities, and insurance rates and taxes vary over a wide range for different states. These factors must be considered when using the cost charts which are presented later.

The costs of foundations and protective coatings are subject to such wide variation that it is impossible to estimate these items in general terms. This is also true of fittings and auxiliary equipment, for although certain fittings are normally furnished with storage tanks, pumps, valves, and piping depend upon the specific installation.

Although the costs of some of these items are difficult to estimate, the following information may prove helpful.

Foundations

The average pressure under a flat-bottom steel tank 40 ft. high and filled with a product having a unit weight approximately equal to that of water will be less than 3000 lb. per sq. ft. The safe bearing capacity of most soils is well in excess of this value. Many large storage tanks are placed on foundations prepared by removing top soil and replacing it with a layer of sand and gravel or crushed stone, at least 6 in. thick and extending at least 2 ft. beyond the shell of the tank. This construction provides adequate drainage under the tank and makes unnecessary any special treatment of the underside of the bottom. Experience indicates that exterior corrosion of the bottom plates will be negligible under normal conditions.

If there is danger of the soil moving from under the tank, a concrete ring wall may be used. This is usually constructed under or adjacent to the shell of the tank. When soil conditions are very poor, it may be necessary to install a concrete slab foundation. This may be supported on piling if the soil conditions make necessary this added cost.

Thus, the cost of preparing adequate foundations may vary from a very nominal charge for normal conditions to a major expense when soil conditions are very poor. For a tank 60 ft. in diameter the range might be from say $300 to $15,000.

Painting and Special Protective Coatings

For the petroleum industry, steel storage tanks are generally erected with no paint applied to any part of the tank. After the tank has been "weathered" for several months, the mill scale can be easily removed by wire brushes; and then the exterior of the tank is usually painted by the user. The interior of such tanks is normally left unpainted. If the tanks are to be painted before placing in service it is desirable to remove rust and mill scale by pickling or by sand, shot, or grit blasting. The cost of such special preparation followed by painting or the application of special protective coatings will be determined by the kind of preparation, the kind and number of coats of paint or other protective coating, and whether all or part of the tank surfaces inside and outside are treated.

Fittings and Auxiliary Equipment

Standard fittings normally furnished with storage tanks

Fred L. Plummer, Director of Engineering, Hammond Iron Works, Warren, Pa.

* This material was submitted by the Methods for Estimating Costs of Engineering Projects Subcommittee, H. G. Ingraham, Chas. T. Main, Inc., Chairman. The committee welcomes and solicits the cooperation of engineers in allied industry companies and in pulp and paper mills in making available for publication in *Tappi* information on construction and equipment costs.

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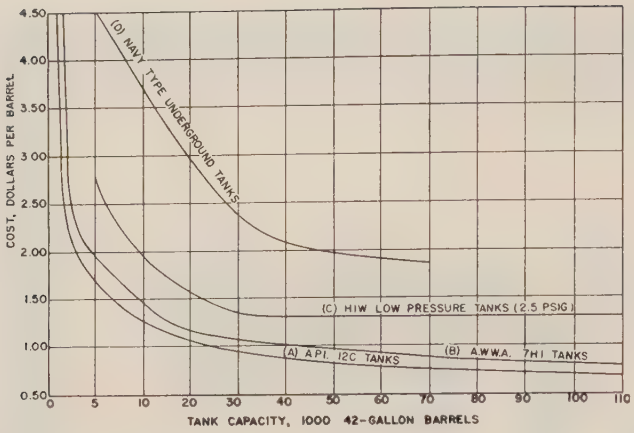
COST, DOLLARS PER BARREL
(D) NAVY TYPE UNDERGROUND TANKS
(C) HIW LOW PRESSURE TANKS (2.5 PSIG)
(A) API. 12C TANKS
(B) A.W.W.A. 7H.1 TANKS
TANK CAPACITY, 1000 42-GALLON BARRELS

Fig. 1. Cost of fixed volume tanks

include: one 20-in. diameter shell manhole, one 20-in. diameter roof manhole, one 6-in. gage hatch, one roof nozzle for vent, one ladder or spiral stairway, two shell nozzles, and one flange for water draw-off.

These fittings are included in the tank costs given in the accompanying charts. Other fittings and auxiliary equipment are considered as special and the cost of such items is not included in the values shown on the charts.

Pumps, valves, and piping are considered to be auxiliary equipment which must be furnished to meet requirements of each specific installation. Special fittings would include such items as: sumps and drains; water draw-off with anti-freeze valve; swing lines; target or ground-reading-type float gages; vents, which may be free or of the conservation type, with size depending upon the type of stored product, temperatures, and pumping rates; flame arresters; foam chambers, including connections; flush cleanout doors or other special or extra openings in the tank shell, roof, or bottom.

COST CHARTS

The costs of field-erected tanks are given in Figs. 1–4. The costs given on these charts cover the cost of materials

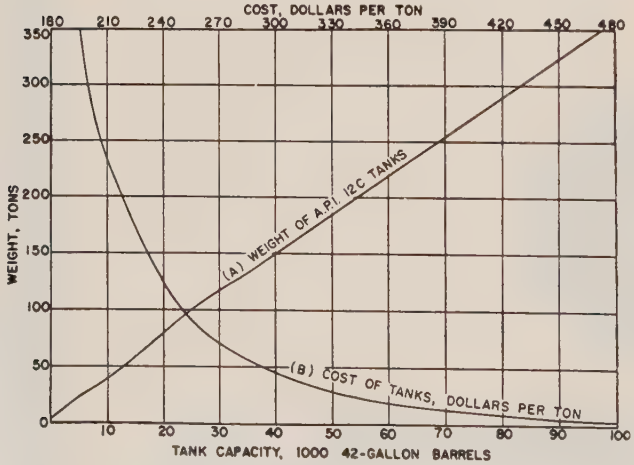
COST, DOLLARS PER TON
WEIGHT, TONS
(A) WEIGHT OF A.P.I. 12C TANKS
(B) COST OF TANKS, DOLLARS PER TON
TANK CAPACITY, 1000 42-GALLON BARRELS

Fig. 2. Cost and weight of API 12C tanks

and fabrication and erection of the tank, including standard fittings, assuming average values for transportation, field labor, insurance, and tax costs. All costs are based on rates in effect during the first quarter of 1952. These costs do not include the cost of foundations, painting (including surface preparation), special fittings, and auxiliary equipment.

FIXED VOLUME STEEL TANKS

1. Cylindrical, Flat-Bottom, Cone or Dome-Roof Tanks

The most generally used type of field-erected storage tank has a flat-bottom, cylindrical shell, and either a cone or dome-shaped roof. Tank diameters vary up to 200 or more ft., and tank shell heights up to 60 or more ft., providing storage capacities for single units up to 250,000 barrels, or more than 10,000,000 gals. For tanks up to about 25 ft. diameter, self-

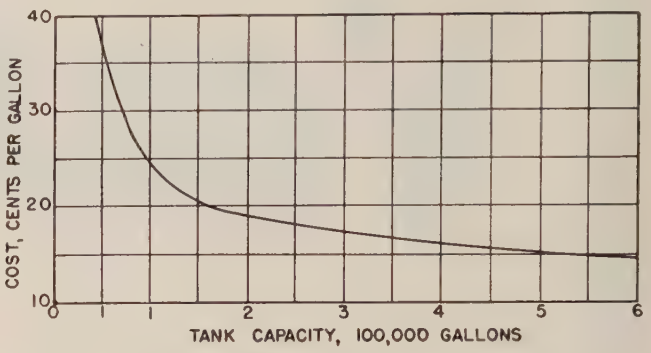

Fig. 3. Cost of AWWA 7H.1 elevated water tanks

supporting cone roofs consisting of unstiffened radial plates having a slope of $2^1/_2$ in. in 12 or steeper may be used. Unstiffened umbrella roofs with radial plates rolled in the radial direction to the roof radius, or dome roofs with radial plates dished to form a spherical segment may be used on tanks having diameters up to say 50 ft. Self-supporting dome roofs with a system of stiffening beams can be used on tanks of larger diameter. However, the most economical and most generally used type of roof for all sizes of this type of tank consists of rectangular plates forming a flat cone having a slope of $^3/_4$ in. in 12 and supported by radial rafters which are in turn supported by one or more columns (depending upon the diameter of the tank) and a system of girders when there is a center column plus one or more rings of additional columns.

Roof supporting structures are usually designed in accordance with AISC Specifications for buildings or in accordance with API or AWWA Specifications for tanks. The design of tank roof, shell, and bottom plates depends upon service conditions and may be governed by customer specifications or by one of several generally recognized standard codes.

(a) Tanks for Storage of Noncorrosive Liquids with Specific Gravity Less Than Unity

The American Petroleum Institute Specification for Welded

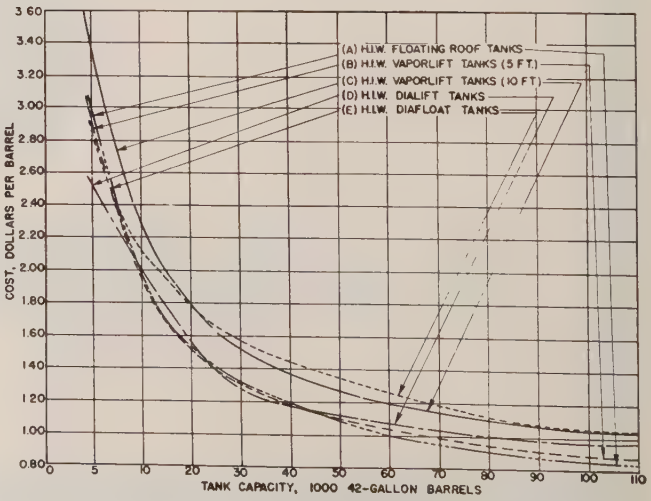
(A) H.I.W. FLOATING ROOF TANKS
(B) H.I.W. VAPORLIFT TANKS (5 FT.)
(C) H.I.W. VAPORLIFT TANKS (10 FT.)
(D) H.I.W. DIALIFT TANKS
(E) H.I.W. DIAFLOAT TANKS
COST, DOLLARS PER BARREL
TANK CAPACITY, 1000 42-GALLON BARRELS

Fig. 4. Cost of variable volume tanks

Groundwood Pulp

FIRM: Hoberg Paper Mills, Little Rapids Division

LOCATION: West DePere, Wisconsin

Plant, recently purchased by Hoberg, engages in groundwood pulp bleaching. Efficiency of bleaching operations increased through High Density Bleaching System using J-C Pulp Press and J-C Bleach Mixer. Results successful. Plant now handling 30 tons/day.

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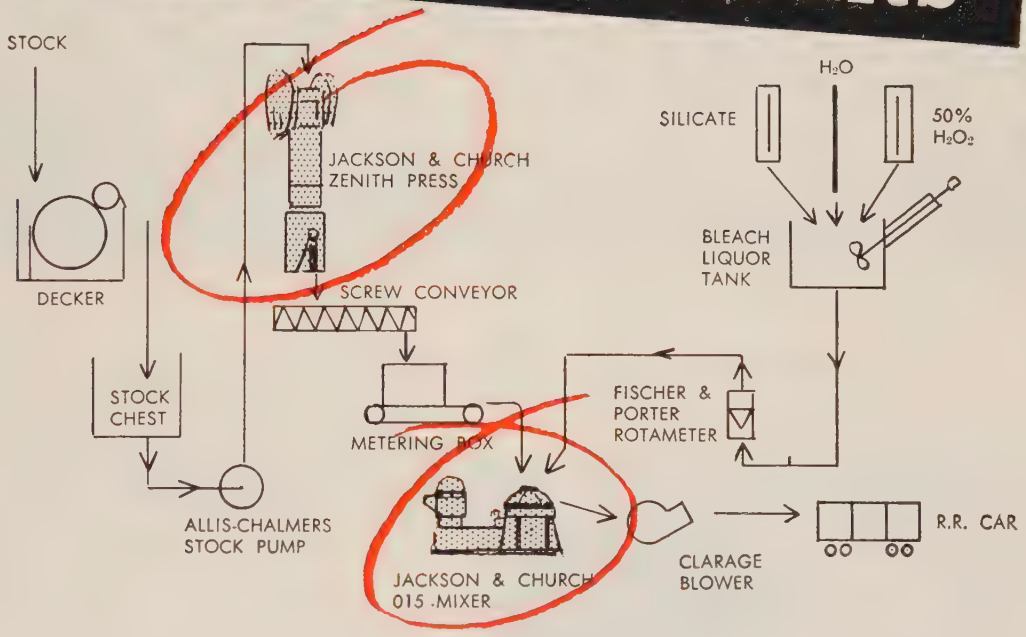

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Fig. 5. API 12C cone roof tanks with steel firewalls

Oil Storage Tanks (API Std. 12C) is very generally used as a basis for the design, fabrication, and erection of tanks to be used for the storage of all types of noncorrosive liquid products which have a unit weight less than that of water. Figure 5 shows three 96,000-barrel storage tanks of this type together with steel firewalls. Curve A of Fig. 1 shows the costs, as previously defined, for tanks of this type constructed in accordance with API Std. 12C.

(b) Tanks for Storage of Water

Standard Specifications for Standpipes and Reservoirs of the American Water Works Association, the National Board of Fire Underwriters, or the Associated Factory Mutual Fire Insurance Co. are normally used as a basis for the design, fabrication, and erection of tanks to be used for the storage of water. The design rules given in these specifications are more conservative than those given in API 12C and require the use of thicker shell plates for a tank of any given size. Curve B of Fig. 1 shows the costs, as previously defined, for tanks of this type constructed in accordance with AWWA 7H.1.

(c) Tanks for Storage of Corrosive Liquids and Those with Specific Gravity Greater Than Unity

Tanks to be used for the storage of noncorrosive liquids which have a unit weight greater than water may be designed in accordance with the specifications listed above under

Fig. 6. Low-pressure storage tanks

(a) and (b) by increasing the shell plate thickness in proportion to the increase in unit weight of the stored product.

There is no generally recognized code or specification which covers the design and construction of tanks to be used for the storage of corrosive liquids. Recommended rules may be found in Hammond Iron Works Bulletin 49B.

Fig. 7. Spheres and bullets for high-pressure storage

The weight of steel in tanks for these services will depend upon the service conditions and design requirements set up by the purchaser. The cost may be estimated by determining the weight of the tank and using the data given in Fig. 2. Curve A shows the total weight of Std. API 12C tanks and curve B shows the cost per unit weight as the total weight varies. The unit weight costs may be applied to tanks of the type discussed in this section to obtain approximate costs.

(d) Tanks for Storage of Volatile Liquids

Cylindrical, flat-bottom, dome-roof tanks can be designed to operate at low pressures and prevent vapor losses due to "breathing" for products such as gasoline. Both theory and experience indicate that such tanks designed to operate with vents set at pressures up to say 2.5 p.s.i.g. can be used for the storage of gasoline and similar products without the loss of any significant quantity of product vapor due to "breathing" effects. Special shape tanks such as "spheroids" are sometimes used for this same service. Figure 6 shows a view of two low-pressure tanks with globe roofs and flat bottoms having storage capacities of 27,500 and 5000 barrels and designed to withstand a vapor pressure of 2.5 p.s.i.g. In these tanks, diagonal ties connecting stiffener beams attached to the tank shell and the flat-tank bottom are provided to prevent distortion and excessive stresses at the shell-to-bottom connection when the liquid level is low and a vapor pressure exists in the tank. These ties and stiffener beams are designed for low working stresses and are constructed so as to avoid high bending stresses in the tank bottom and shell plates. Working stresses used for determining the thickness of shell plates are more conservative than those allowed by AWWA 7H.1 which are in turn more conservative than those allowed by API 12C. Tanks of this type can be designed to operate economically at vapor pressures up to 15 p.s.i.g. Curve C in Fig. 1 gives the costs, as previously defined, for tanks of this type designed to operate at 2.5 p.s.i.g. pressure in accordance with Hammond Iron Works standard design rules.†

† A new API Code is now being prepared which will give rules covering the design, fabrication, and erection of large field-erected, low-pressure tanks.

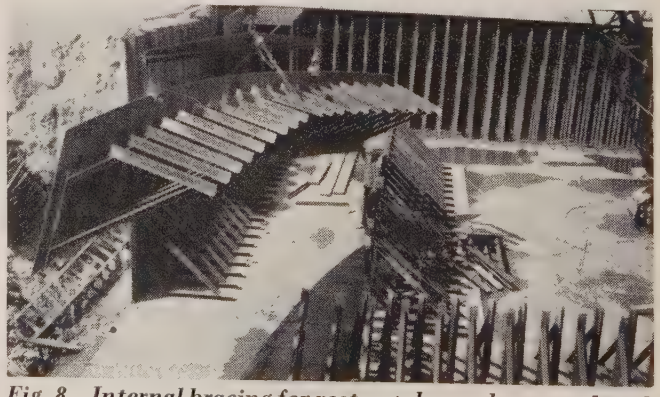
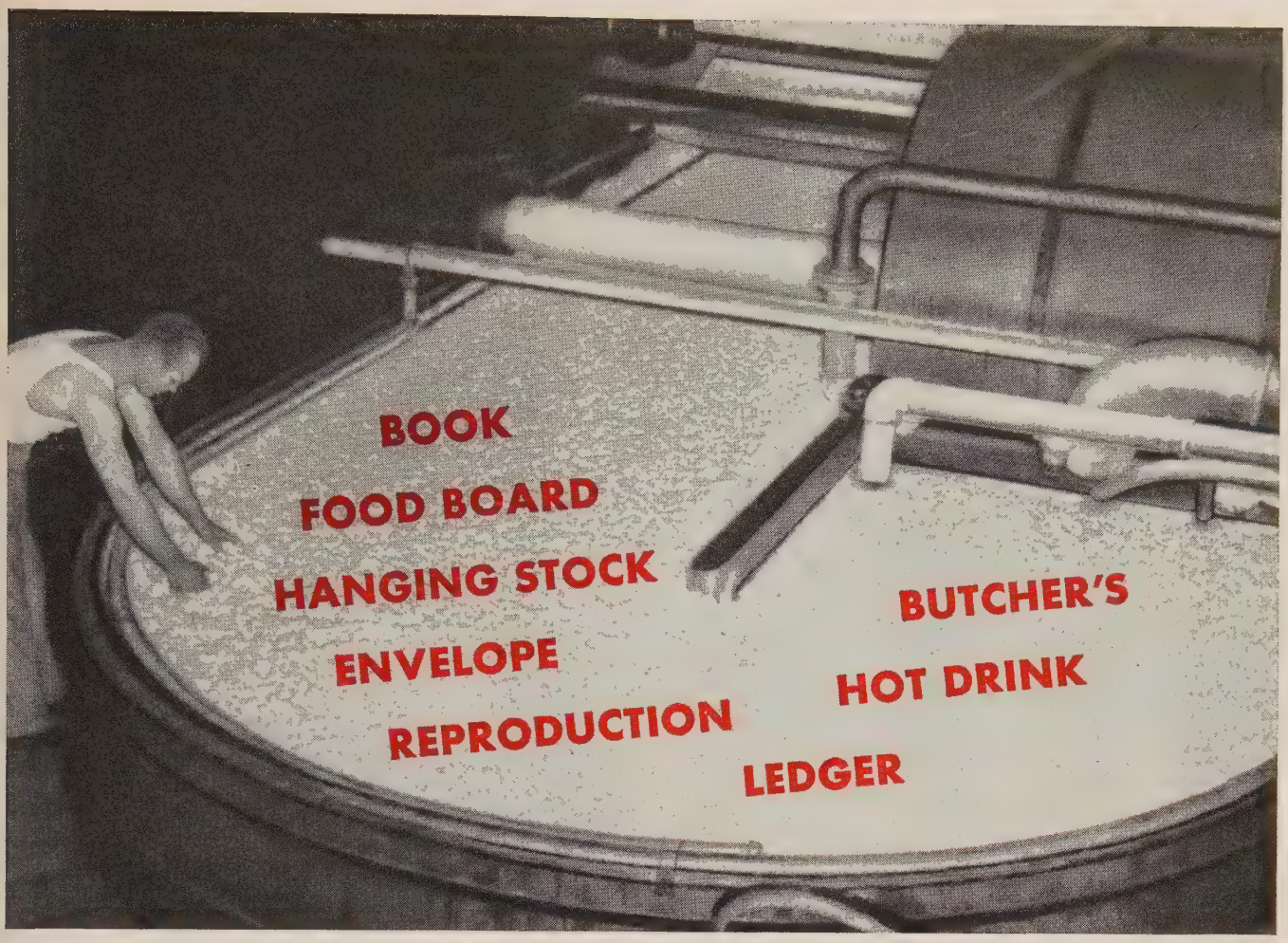


Fig. 8. Internal bracing for rectangular underground tank



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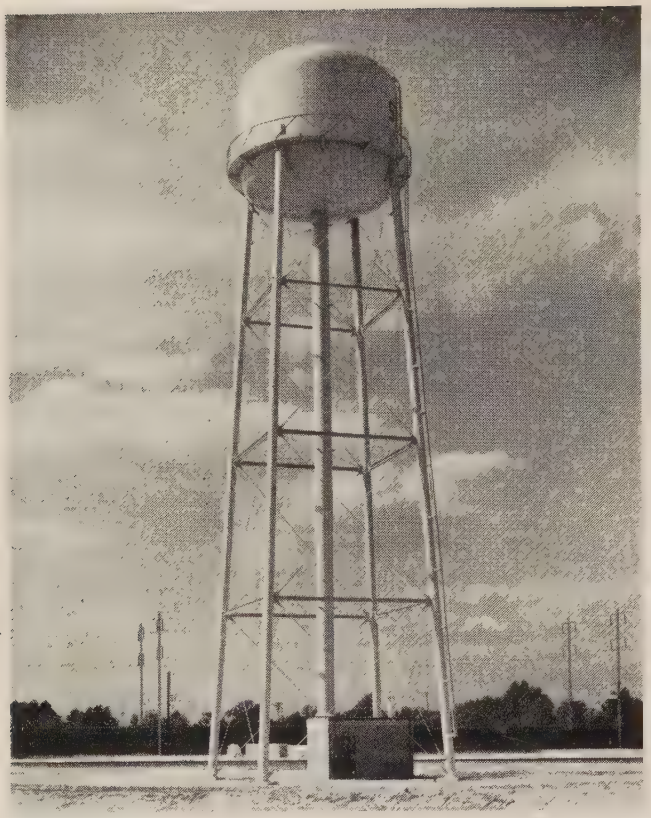

Fig. 9. 100,000-gal. elevated water tank

2. Spheres, Bullets, and Special Shape Tanks

It is often necessary to store air, various gases, and highly volatile liquids at relatively high pressures from 15 up to 300 p.s.i.g. or more. Spherical tanks or cylindrical tanks with dished or hemispherical ends (often referred to as bullets or blimps) will normally be found to be most economical for such services. These tanks are usually designed, fabricated, and erected in accordance with the rules of the ASME or the API-ASME Unfired Pressure Vessel Codes. Figure 7 shows a typical installation of tanks of these types. The spheres are 30 and 38 ft. in diameter and are designed for storage of liquids with working vapor pressures of 30 and 100 p.s.i.g. The cylindrical vessels are 12 ft. in diameter and 62 ft. long over all. These were also designed for the storage of liquids with working vapor pressures of 30 and 100 p.s.i.g.

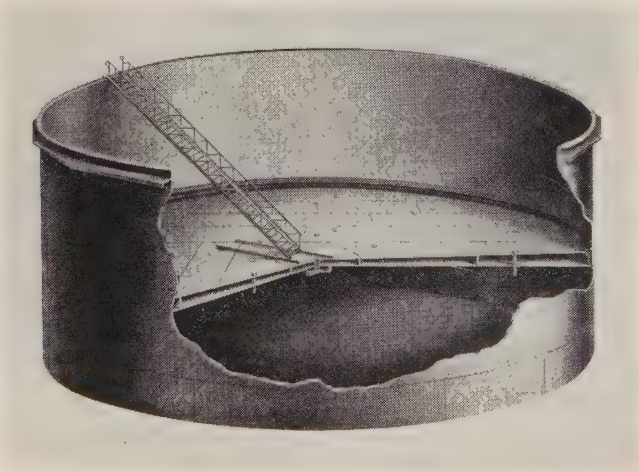

Fig. 10. Hammond double-deck floating roof tank

Service and design requirements vary so widely for these types of vessels that it is not practical to construct cost charts. The following tabulation includes several typical examples which may be used as guides in estimating such costs.

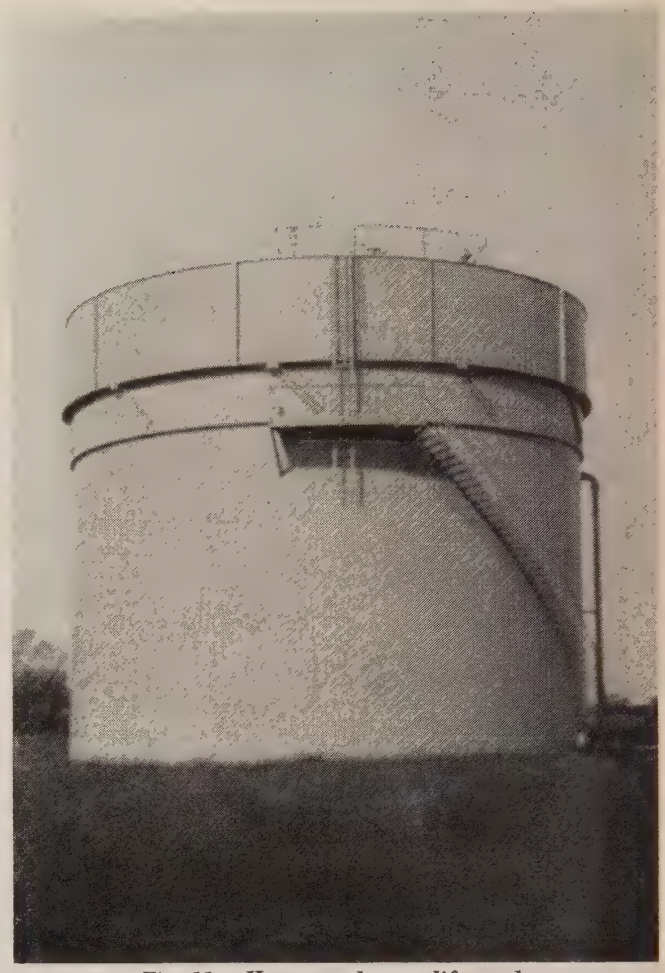

Fig. 11. Hammond vaporlift tank

(a) Sphere 72 ft. 6 in. diameter, air storage, full vacuum or 60 p.s.i.g. pressure, ASME 1950 Code; weight 435 tons; cost $350 per ton.
(b) Sphere 51 ft. 3 in. diameter, liquid storage, 75 p.s.i.g. pressure, API-ASME Code; weight 250 tons; cost $350 per ton.
(c) Sphere 38 ft. 0 in. diameter, liquid storage, 70 p.s.i.g. pressure, API-ASME Code; weight 106 tons; cost $455 per ton.
(d) Sphere 25 ft. 3 in. diameter, liquid storage, 20 p.s.i.g. pressure, API-ASME Code with $^1/_4$-in. corrosion allowance; weight 25 tons; cost $750 per ton.
(e) Horizontal bullet, 16 ft. 0 in. diameter, 34 ft. 0 in. out-to-

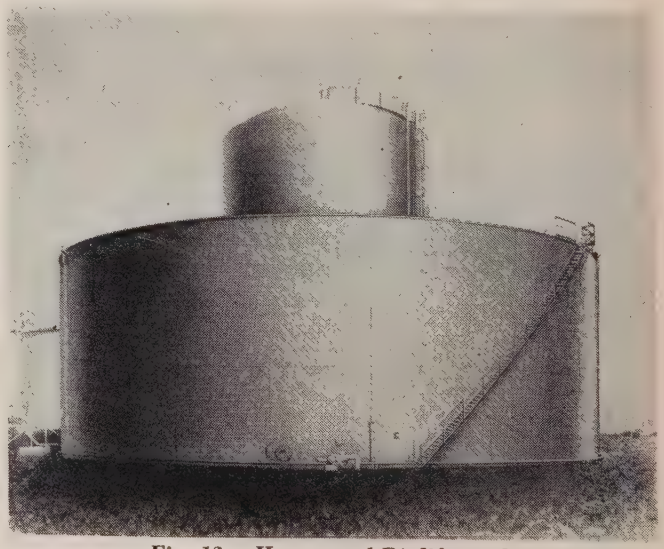

Fig. 12. Hammond Dialift tank

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out of hemispherical ends, liquid storage with corrosion allowance, saddle supports and internal baffles; weight 25 tons; cost $550 per ton.

(f) Horizontal bullet, 10 ft. 6 in. diameter, 63 ft. 0 in. straight shell with ASME dished heads, saddle supports, API-ASME Code, liquid storage, 50 p.s.i.g.; weight 17 tons; cost $353 per ton f.o.b. fabricating plant.

(g) Process vessel, 30 ft. 0 in. diameter by 28 ft. 9 in. high cylinder with ellipsoidal roof and 55° cone bottom, supported on columns, and with interior cone and baffles, ASME 1949 Code U69 construction, corrosion allowance, 20 p.s.i.g., platforms and stairs; weight 120 tons; cost $700 per ton.

3. Underground Tanks

In certain metropolitan areas and in other restricted areas, such as those near some airports, it is required that flammable products be stored in underground tanks. In areas such as New York where land values are very high such tanks are frequently built with straight sides forming a rectangular prism or other special shape which fits the available site. These tanks must be braced internally to withstand the external earth pressure as well as internal pressures. Figure 8 shows a construction view of a large underground pressure vessel designed to operate by the "Aqua Flotation System" with a hydrostatic pressure of 45 p.s.i.g. acting at the top of the tank. The tank is 85 ft. square and 12 ft. deep.

Many underground tanks have been constructed for our armed forces. These tanks have generally been cylindrical with flat roofs and bottoms.

The costs, as previously defined, for rectangular underground tanks constructed in accordance with the requirements of New York City for the storage of gasoline or fuel oils vary irregularly depending upon the tank size, tank proportions, number of compartments, etc. These tanks are tested full of water with a hydrostatic pressure of 15 p.s.i.g. applied at the top of the tank before any earth back fill is made around or over the tank. The average cost is about $2.50 per barrel for medium-size tanks. This may increase to about $4.00 per barrel for small (6000 barrel) tanks or for tanks of uneconomical proportions.

Curve D of Fig. 1 gives the costs, as previously defined, for circular underground tanks constructed in accordance with the usual requirements of our armed forces.

4. Elevated Water Tanks

Elevated tanks for the storage of water are normally constructed in accordance with the specifications given previously for fixed volume steel tanks for the storage of water. The tank is usually cylindrical with ellipsoidal bottom and either cone or ellipsoidal roof. The height of the tower depends upon service requirements. Figure 9 shows a typical elevated tank having ellipsoidal roof and bottom with a capacity of 100,000 gal. and a height of 100 ft. from the base of the column to the bottom capacity line.

Figure 3 gives the costs, as previously defined except that standard AWWA painting is included, for elevated tanks of the type shown in Fig. 9 with tower heights required to keep the bottom capacity line 100 ft. above the top of the foundations. Costs, of course, will vary for other tower heights and for tanks with cone roofs or tanks of special shapes.

VARIABLE VOLUME STEEL TANKS

It is possible to eliminate all or part of the "breathing" and "filling" losses of vapors of volatile products by the use of variable volume storage tanks. Open-top tanks with roofs which float on the surface of the stored liquid product are very effective in eliminating "filling" losses which become critical when the storage tank is a working tank that is filled and emptied many times a year (more than say eight times for products such as gasoline). If the space between the floating roof and the shell of the tank is closed by a suitable sliding shoe and seal membrane, "breathing" losses will also be materially reduced.

Other types of variable volume tanks include those with lifter roofs or with a fixed roof and an auxiliary housing containing a flexible membrane which acts as a "lung." These types of installations provide a variable volume for vapor storage and are effective in eliminating all "breathing" losses and in reducing "filling" losses.

1. Tanks with Floating Roofs

Tanks with floating roofs are usually constructed in accordance with the rules of API 12C. Three types of floating roofs —double-deck, pontoon, and pan—are supplied by Hammond Iron Works. Figure 10 shows the construction of a Hammond double-deck floating roof tank. The double-deck roof is most efficient and provides greatest stability. For large-diameter tanks the pontoon and pan types are somewhat more economical; however, the pan type is not normally used in areas where heavy snows may be expected. Curve A of Fig. 4 shows the costs, as previously defined, for steel tanks with Hammond double-deck floating roofs constructed in accordance with API 12C. Tanks 60 to 150 ft. in diameter with pontoon roofs will cost from 0 to 6% less than those with double-deck roofs.

2. Tanks with Lifter Roofs

Tanks with lifter roofs are also normally constructed in accordance with the rules of API 12C. Figure 11 shows the construction of a Hammond vapor-lift tank to which several fixed volume tanks are interconnected. The roof lifts as pressure in the vapor space increases, providing an increase in the vapor storage capacity, and preventing venting of the air-vapor mixture. The vapor spaces of other fixed volume

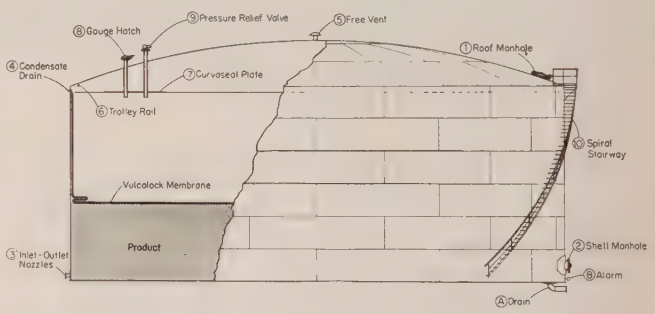

Fig. 13. Hammond Diaflote tank

tanks may be manifolded to the vapor space of a Hammond vapor-lift tank thus reducing or eliminating "breathing" losses for the entire group of tanks. Curves B and C of Fig. 4 give the costs, as previously defined, for Hammond vapor-lift tanks constructed in accordance with API 12C and having roof lifts of 5 or 10 ft., respectively. The height of roof lift determines the amount of expansion available. Higher lifts are used when fixed volume tanks are interconnected so as to provide adequate expansion for the larger volume of stored product.

3. Tanks with Diaphragms

The Hammond Iron Works supplies two types of tanks which include internal, flexible, impervious diaphragms suitable for use in contact with petroleum products and their vapors, as well as many other products. These tanks are also constructed in accordance with the rules of API 12C.

(a) Hammond Dialift Tanks

A Hammond Dialift tank consists of a bucket-shaped membrane attached to the inside periphery of a cylindrical housing placed on top of a conventional cone-roof storage tank, thus producing a space of variable volume which functions as the lung of the storage tank. The membrane lifts under a slight

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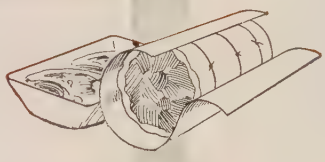

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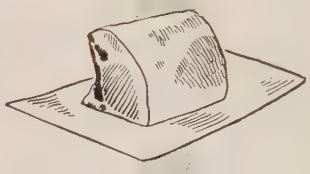
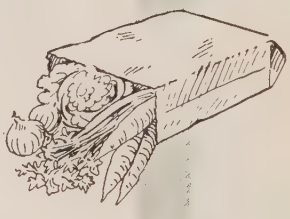
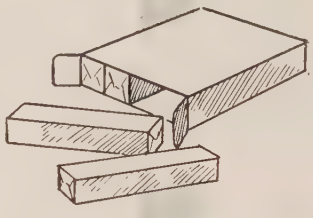


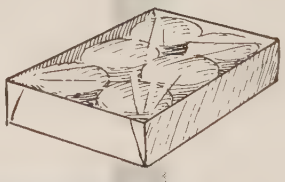
FOR WET VEGETABLES —"Quilon" gives paper outstanding size and water repellency . . . ideal properties for wet-vegetable bags, potato bags, grocery bags and shipping containers.



FOR BUTTER AND MARGARINE —Greaseproof or laminated foil wraps have better release properties when treated with "Quilon." What's more, "Quilon" checks "oil crawl" or grease migration.



FOR BAKED GOODS —The superior release properties "Quilon" provides are especially beneficial in packages for "brown and serve" rolls, sweet rolls, cakes and other baked goods.



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Wilmington 98, Delaware

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pressure when additional vapor storage space is needed, and lowers when less vapor space is required. The size of the housing and membrane determines the amount of expansion available. The vapor spaces of several fixed volume storage tanks may be interconnected to a single Hammond Dialift tank and all "breathing" losses will be eliminated if the system is properly proportioned. Figure 12 shows the construction of a Hammond Dialift tank. The bucket-shaped diaphragm is attached to the housing at about mid-height with the bottom resting on top of the cone-roof tank when no extra vapor space is required. The diaphragm lifts and reverses itself, resting against the dome roof of the housing, when fully expanded.

Curve D of Fig. 4 gives the costs, as previously defined, for Hammond Dialift tanks constructed in accordance with API 12C and having expansion capacities equivalent to 10% of the liquid storage capacity of the indicated cone-roof tank. For greater or less expansion capacity the cost, of course, would be slightly changed.

(*b*) *Hammond Diaflote Tanks*

Hammond Diaflote tanks are cylindrical, flat-bottom tanks with self-supporting cone or dome roofs, equipped with flexible, gas-impervious membranes attached to the shells of the tanks and shaped to fit the inside walls and bottoms of the tanks. The membrane rests on the surface of any liquid stored in the tank and at all times provides a vapor and liquid-tight barrier between the stored product and the air space above the membrane. These tanks may be used effectively to:

1. Eliminate breathing and filling losses of volatile products
2. Prevent contamination or dilution of high-purity products by excluding condensate
3. Exclude air from deaerated products
4. Decrease corrosion inside tank shell and roof due to corrosive products
5. Reduce fire hazards resulting from vapors of flammable products.

Figure 13 shows the construction of a Hammond Diaflote tank with fittings which are normally used. Curve E of Fig. 4 gives the costs, as previously defined, for Hammond Diaflote tanks constructed in accordance with API 12C.

REFERENCES

For more detailed descriptions of the various types of tanks, including discussions indicating when the use of each type will normally be found to be more advantageous, readers are referred to the following bulletins and technical articles, all of which may be secured by writing to the Hammond Iron Works, Warren, Pa.

Bulletin 49B Hammond Storage Tanks for General Service
Bulletin 51F Hammond Floating Roof Tanks
Bulletin 51DF Hammond Diaflote Tanks
Bulletin 50D Hammond Dialift Tank
Bulletin 50VL Hammond Vapor-Lift Tanks
Bulletin 50P Hammond Globe Roof Pressure Tanks
Bulletin 50U Hammond Underground Steel Storage Tanks
Field-Erected Pressure Vessels
Field-Welded Pressure and Variable Volume Storage Tanks
Use of Aluminum in the Petroleum Industry

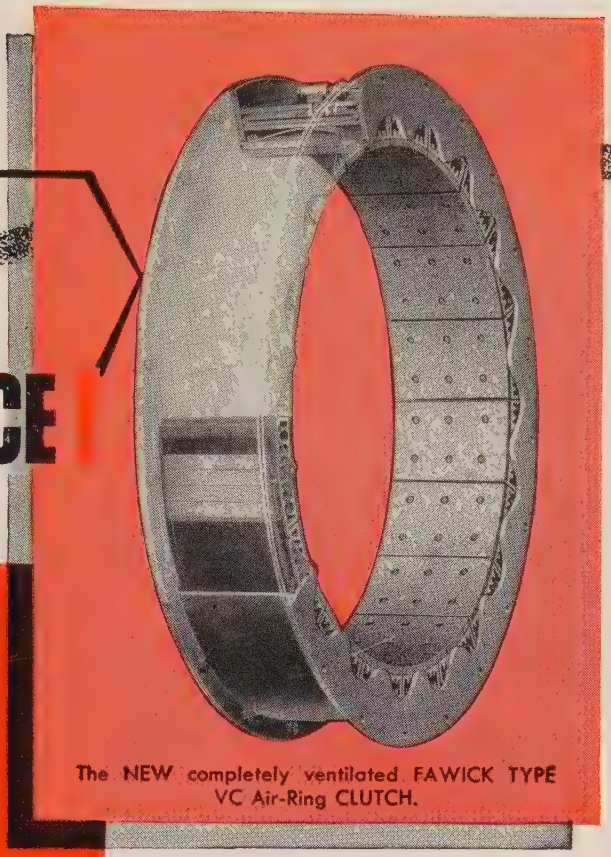
Cost of Recording, Controlling, and Indicating Instruments

Publication of the following table of the cost of various types of recording, controlling, and indicating instruments commonly used in the paper industry prepared by The Foxboro Co., Foxboro, Mass., has been arranged by the TAPPI Committee investigating "Methods for Estimating Construction Costs." The cost of instruments in the modern paper mill, exclusive of installation, may amount to 1 per cent or more of the total construction cost of the project. Management is becoming alert to the possibilities of cost reduction and product improvement through the use of industrial control instruments. Almost every paper mill construction project includes some type of instrumentation. The following prices are presented as a quick reference for the paper mill plant engineer, technical staff, or executive to assist in the preparation of preconstruction cost estimates. To the controller prices listed below should be added the control valve prices. Inasmuch as the cost of these valves will vary widely with the application, it is impractical to include them here. Installation costs will vary depending upon local conditions. Considerable saving in time and expense results in using completely assembled and finished cabinets which are factory engineered. Only a few external connections are then needed to complete the installation.

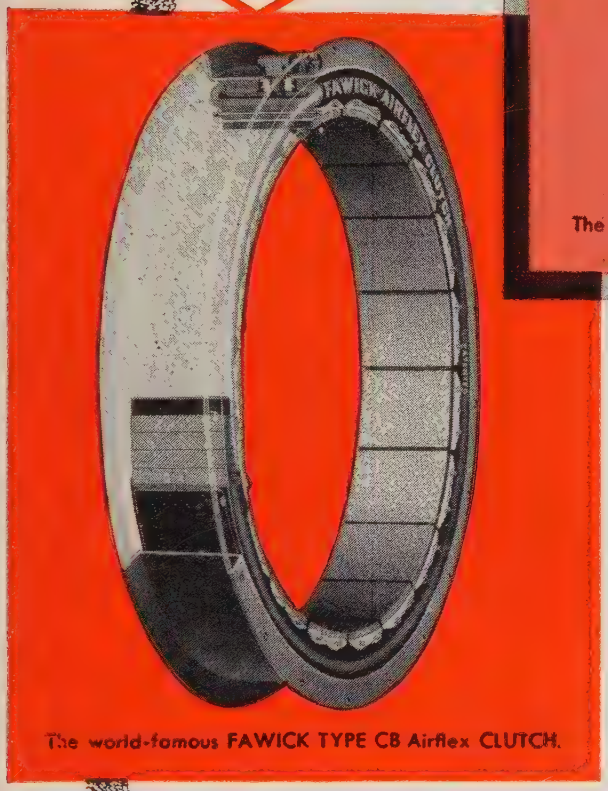
Cost of Industrial Instruments—Recorders, Controllers, Indicators

Type of instrument	*Description*	*Approximate cost, dollars*
Pressure Indicators	6-in. circular case	
	Ranges: 0–30 in. mercury vacuum to 0–20,000 p.s.i.g.	30
Recording Pressure Gages	12-in. circular case	
	Ranges: (a) 21 in. water to 0–2000 p.s.i.g.	100
	(b) 0–2000 to 0–4000 p.s.i.g.	110
	(c) 0–4000 to 0–6000 p.s.i.g.	120
	(d) 0–6000 to 0–10,000 p.s.i.g.	160
	(e) 0–10,000 to 0–50,000 p.s.i.g.	200
	(f) 0–50,000 to 0–85,000 p.s.i.g.	330
	(g) 0–4 in. mercury vacuum to 0–35 p.s.i. abs.	160
Recording Pressure Controllers (Air-Operated)	12-in. circular case	
	Ranges: 0–21 in. water to 0–2000 p.s.i.g.	
	With: 1. On-off control action	200
	2. Proportional control action	220
	Rectangular case	
	Ranges: 0–21 water to 0–2000 p.s.i.g.	
	With: 1. On-off control action	235
	2. Proportional control action	310
	3. Proportional plus reset control action	360
	Note: For other ranges use above range and price listing to compute approximate differentials.	
Indicating Flowmeters	6-in. circular case, industrial mercury manometer, 1000 p.s.i.g. max. working pressure	
	Ranges: (a) 0–10 in. water differential	150
	(b) 0–20 to 0–100 in. water differential	130
	(c) 0–200 in. water differential	160

FAWICK GIVES YOU YOUR CHOICE



The NEW completely ventilated FAWICK TYPE VC Air-Ring CLUTCH.



The world-famous FAWICK TYPE CB Airflex CLUTCH.

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Clutch design features found only in this new VC CLUTCH include (1) cooler operation inherent in drum clutch design; (2) isolation of the operating tube from the heat-generating friction surface; (3) riveted, replaceable friction lining; (4) loose, expanding operating tube which can be replaced without removing the clutch from the shaft.

This FAWICK rigid-type VC CLUTCH is unmatched for heavy-duty service where high starting loads or sustained slippage generate high operating heat that lowers operating efficiency and shortens clutch life. The cooler operation and other advantages found in the FAWICK TYPE VC provide "new clutch" performance throughout a long, maintenance-free life.

For Further Information write for Bulletins 400-A and ML-102.

FAWICK AIRFLEX DIVISION
FEDERAL FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO

FAWICK Airflex
INDUSTRIAL CLUTCHES AND BRAKES

Type of instrument	*Description*	*Approximate cost, dollors*
Recording Flowmeters	12-in. circular case, industrial mercury manometer, 1800 p.s.i. max. working pressure	
	Ranges: (a) 0–10 in. water differential	195
	(b) 0–20 in. to 0–200 in. water differential	180
	(c) 0–320 in. water differential	190
	(d) 0–400 in. water differential	190
	Notes:	
	1. Addition of static pressure pen to instrument with any of the above ranges	35
	2. Addition of temperature pen to instrument with any of the above ranges	90
	3. Addition of electric integrator to instrument with any of the above ranges	135
Recording Flow Controllers (Air-Operated)	Rectangular case, industrial mercury manometer, 1800 p.s.i. max. working pressure	
	Ranges: 0–10 in. water differential	
	With: 1. Proportional control action	410
	2. Proportional plus reset control action	460
	Note: For other ranges use above range and price listings to compute approximate differentials.	
Liquid Level Indicators	6-in. circular case	
	Ranges: 0–20 to 0–165 in. water	
	1. Diaphragm box type	85
	2. Continuous purge type	70
Liquid Level Recorders	12-in. circular case	
	Ranges: 0–20 to 0–165 in. water	
	1. Diaphragm box type	140
	2. Continuous purge type	125
	3. Differential type	210
Liquid Level Controllers (Air-Operated)	Rectangular case, differential type, 1800 p.s.i. max. working pressure	
	Ranges: 0–20 in. to 0–165 in. water	
	With: 1. Proportional control action	425
	2. Proportional plus reset control action	475
Indicating Thermometers	6-in. circular case	
	1. Liquid expansion type	65
	2. Vapor pressure type	55
	3. Gas pressure type	65
	4. Liquid expansion, fully compensated	80
Recording Thermometers	12-in. circular case	
	1. Liquid expansion type	140
	2. Vapor pressure type	130
	3. Gas pressure type	140
	4. Liquid expansion, fully compensated	155
Recording Temperature Controllers (Air-Operated)	12-in. circular case, liquid expansion type	
	With: 1. On-off control action	235
	2. Proportional control action	260
	Rectangular case, liquid expansion type	
	With: 1. On-off control action	270
	2. Proportional control action	350
	3. Proportional plus derivative	390
	4. Proportional plus reset	400
	5. Proportional plus reset and derivative	440
	Note: For other types, use type and price listing for 12-in. circular case recorders to compute approximate differentials.	
Humidity Recorders	12-in. circular case, wet and dry-bulb	
	1. Continuous flow wick type	220
	2. Bottle reservoir wick type	225
	3. Automatic level wick type	240
	4. Porous sleeve type	255
	5. Porous sleeve for pipe line	265
Recording Humidity Controllers (Air-Operated)	12-in. circular case, wet and dry-bulb with on-off control action	
	1. Continuous flow wick type	350
	2. Bottle reservoir wick type	360
	3. Automatic level wick type	380
	4. Porous sleeve type	390
	5. Porous sleeve for pipe line	400
Potentiometer Indicators	Wall-type, null-method, 17-in. circular temperature scale, single-range	195
	Key-type selector switch for above, price per point	7
Potentiometer Controllers (Nonrecording)	Intermittent brush contact or continuous mercury contact models with external drive units	310
Resistance Thermometer Indicators	Wall-type, null-method, Wheatstone bridge, 17-in. circular temperature scale	195
	Key-type selector switch for above, price per point	7
Resistance Thermometer Controllers (Nonrecording)	Intermittent brush contact or continuous mercury contact models with external drive units	310
E.m.f. Actuated Electronic Indicators or Recorders	Rectangular case, continuously self-balanced, null-balance type, standard ranges for any of the following: (1) temperature, (2) temperature difference, (3) pH, (4) voltage, (5) motor load, (6) speed	415
E.m.f. Actuated Electronic Indicating or Recording Controllers (Air-Operated)	Rectangular case, continuously self-balanced, null-balance type, standard ranges for temperature, pH, speed, temperature difference, voltage, and motor load:	
	With: 1. On-off control action	500
	2. Proportional control action	580
	3. Proportional plus derivative	600
	4. Proportional plus reset	620
	5. Proportional plus reset and derivative	650
Resistance Actuated Electronic Indicators or Recorders	Rectangular case, continuously self-balanced, null-balance type, standard ranges for:	
	1. Temperature	400
	2. Cell applications	425
	3. Resistance	440
	4. Temperature difference	475

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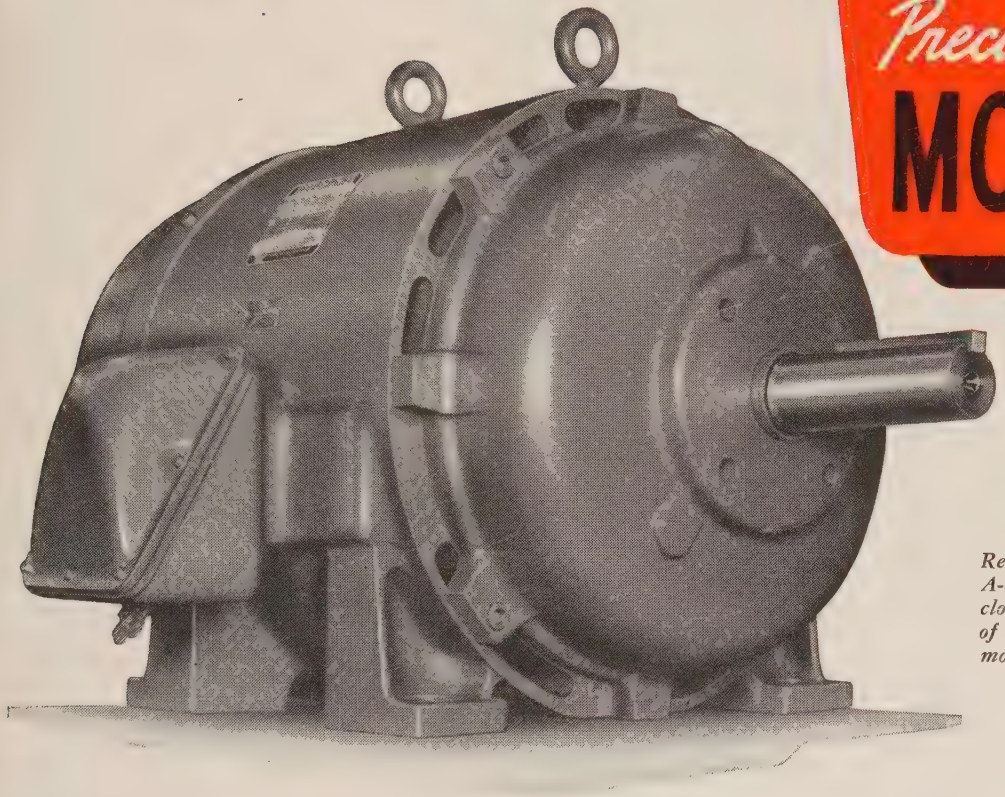

Reliance Totally-enclosed Fan-cooled A-c. Motor. All other standard enclosures available, with wide choice of mechanical designs and special mountings. Ratings from 3/4 to 300 hp.

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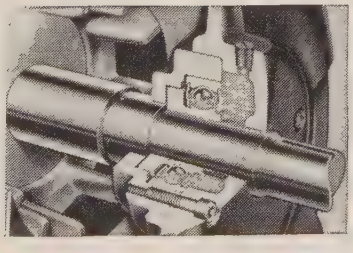

. . . AND THE BEST PRE-LUBRICATED BEARING DESIGN

The Reliance pre-lubricated bearing provides *four times more operating hours without re-lubrication* than any other bearing used in motors today. And—whatever your lubrication schedule—*you just can't grease'em wrong!* To get the complete "inside story" on motor bearings, write today for Bulletin B-2201. It contains hard facts on the advantages of the Reliance pre-lubricated bearing design, with cutaway view, cross-section diagram, comparison chart, and statements by bearing manufacturers. B-1458 J

RELIANCE ELECTRIC AND ENGINEERING CO.

1059 Ivanhoe Road, Cleveland 10, Ohio • *Sales Representatives in Principal Cities*

Type of instrument	*Description*	*Approximate cost, dollars*
Resistance Actuated Electronic Indicating or Recording Controllers (Air-Operated)	Rectangular case, continuously self-balanced, null-balance type, standard ranges for:	
	1. Temperature	
	With: (a) On-off control action	500
	(b) Proportional control action	580
	(c) Proportional plus derivative	600
	(d) Proportional plus reset	620
	(e) Proportional plus reset and derivative	650
	2. Cell application	
	With: (a) On-off control action	510
	(b) Proportional control action	590
	(c) Proportional plus derivative	610
	(d) Proportional plus reset	630
	(e) Proportional plus reset and derivative	660
	3. Resistance	
	With: (a) On-off control action	540
	(b) Proportional control action	620
	(c) Proportional plus derivative	640
	(d) Proportional plus reset	660
	(e) Proportional plus reset and derivative	690
	4. Temperature difference	
	With: (a) On-off control action	575
	(b) Proportional control action	655
	(c) Proportional plus derivative	675
	(d) Proportional plus reset	705
	(e) Proportional plus reset and derivative	735
Electric Measuring Accessories	pH electrode assemblies, immersion or flow type	90
	pH amplifier, nonindicating	475
	pH connection box	15
	Thermocouple assemblies, 12-in. socket length, IC, chromel-alumel or copper constantan couples	20
	Extension lead wire for above, per 100 ft	15
	Resistance bulb assemblies, 5-in. socket length	40
Flowmeter Accessories	Orifice plates, bored steel, line size:	
	2-in. size	6
	4-in. size	7
	6 in. size	8
	8-in. size	11
	10-in. size	15
	20-in. size	45
	Venturi tubes, cast-iron tubes with bronze throats, 125 lb. rating, line size:	
	2-in. size	300
	4-in. size	400
	6-in. size	450
	8-in. size	520
	10-in. size	700
	20-in. size	1900
	Pitot tubes, brass, single support type, line size:	
	6-in. size	25
	10-in. size	30
	16-in. size	32
	20-in. size	33
	Orifice flange unions, 300 lb., rating, forged steel, line size:	
	2-in. size	20
	4-in. size	30
	6-in. size	50
	8-in. size	55
	10-in. size	75
	20-in. size	300
Pneumatic Indicating Transmitters	Circular case, 3–15 p.s.i. transmitted signal, for:	
	1. Temperature	225
	2. Pressure	180
	3. Absolute pressure	240
	4. Flow	270
	5. Liquid level (differential type)	300
Pneumatic Nonindicating Transmitters	Force balance type, 3–15 p.s.i. transmitted signal for flow, liquid level, differential pressure, 1500 lb. working pressure	240
Pneumatic Indicating Receivers	Circular case, 3–15 p.s.i. receiver element	
	6-in. size	25
	10-in. size	90
	12-in. size	100
Pneumatic Recording Receivers	Rectangular case, circular chart, number of recording pens:	
	1	115
	2	175
	3	230
	4	310
Pneumatic Indicating or Recording Controllers (Air-Operated)	Rectangular case, 3–15 p.s.i. receiver element:	
	With: 1. On-off control action	235
	2. Proportional control action	310
	3. Proportional plus reset	365
	4. Proportional plus reset and derivative	410
	5. Ratio	480

CHEMICAL USERS' GUIDE To General Chemical Products for the Paper Industry

PRODUCT	AVAILABLE FORMS	COMMERCIAL STRENGTH (MIN.)	SHIPPING CONTAINERS	APPLICATIONS
Aluminum Sulfate $Al_2(SO_4)_3 \cdot 14H_2O$ approx. *(Alum)*	Commercial & Iron Free: Lump, Ground Powdered	17.25% Al_2O_3	Bags Bulk Carloads	Precipitation of rosin size and filler; water clarification; manufacture of satin white; pitch control; mordant for dyes.
Aluminum Sulfate $Al_2(SO_4)_3$ + water *(Liquid Alum)*	Liquid	32° Be (total Al_2O_3 7.2%)	Tank Trucks Tank Cars	Same as commercial dry product but lower strength.
Salt Cake Na_2SO_4	White or Grayish Granules	95-99% Na_2SO_4	Bags Bulk Carloads	Used in kraft cooking liquors as the source of Na_2S.
Glauber's Salt, Crystal $Na_2SO_4 \cdot 10H_2O$ *(Sodium Sulfate)*	Colorless Crystals	96% $Na_2SO_4 \cdot 10H_2O$ (42.3% Na_2SO_4)	Bags Barrels Fibre Drums	Substitute for salt cake in kraft cooking liquor.
Glauber's Salt, Anhydrous Na_2SO_4 *(Sodium Sulfate)*	White Granules	99.9% Na_2SO_4	Bags Bulk Carloads	Same as Crystal but stronger product.
Sulfuric Acid H_2SO_4	Liquid	66° (93.19%), 99% 20% oleum and higher strengths	Carboys Steel Drums Tank Trucks Tank Cars	Wire souring; parchmentizing; acid wash in last stage of multi-stage pulp bleaching; neutralizing tall oil soaps; pH adjusting.
Hydrochloric Acid HCl + water *(Muriatic Acid)*	Liquid	18° Be (27.92%) 20° Be (31.45%) 22° Be (35.21%)	Carboys Tank Trucks Tank Cars	Wet strength paper.
Sodium Bisulfite, Anhydrous $Na_2S_2O_5$ *(ABS) (Sodium Metabisulfite)*	Powder	97.5% $Na_2S_2O_5$ (Equiv. 65.5% SO_2)	Bags Fibre Drums	Anti-chlor.
Sodium Silicate $Na_2O \cdot XSiO_2$ + water *(Water Glass)*	Liquid	38°, 41°, 42° Be; special and higher strengths	Steel Drums Tank Cars Tank Trucks	Adhesive for corrugated and solid fibre board; used in coating mixtures to reduce viscosity and in beater sizing to stiffen paper. Aid in bleaching & flocculation.
Chromium Potassium Sulfate $K_2SO_4 \cdot Cr_2(SO_4)_3 \cdot 24H_2O$ *(Potash Chrome Alum)*	Red Violet Crystals	99.5% $K_2SO_4 \cdot Cr_2(SO_4)_3 \cdot 24H_2O$	Fibre Drums	Used in "save-all" or white water systems.
Aqua Ammonia NH_4OH + water *(Ammonia)*	Colorless Liquid	26° Be (29.4% NH_3)	Carboys Steel Drums Tank Trucks	Used with chlorine to form chloramines for slime control.
Sodium Fluoride	Powder	95% NaF 97% NaF	Multiwall Paper Bags Fibre Drums	Preservative and stabilizer for starch in coating mixtures.
Tetrasodium Pyrophosphate, Anhydrous $Na_4P_2O_7$ *(TSPP) (Pyro)*	White Powder	98% $Na_4P_2O_7$ (Equiv. 52% P_2O_5)	Bags Fibre Drums	Felt washing; pitch dispersion; coating.
Sodium Tripolyphosphate $Na_5P_3O_{10}$ *(Tripoly)*	White Powder	90-95% $Na_5P_3O_{10}$ (Total P_2O_5—56%)	Bags Bulk Carloads	Felt washing; pitch dispersion; coating.
Nitric Acid HNO_3 + water	Liquid	42° Be 67.2% HNO_3	Carboys Drums Tank Trucks	Nitrating pulp; cleaning monel metal.

The products advertised are commercial chemicals having various uses, some of which may be covered by patents, and the user must accept full responsibility for compliance therewith.

OTHER PRODUCTS: Sodium Sulfite; Sodium Thiosulfate; Sodium Metasilicate; Trisodium Phosphate; Copper Sulphate; Disodium Phosphate.

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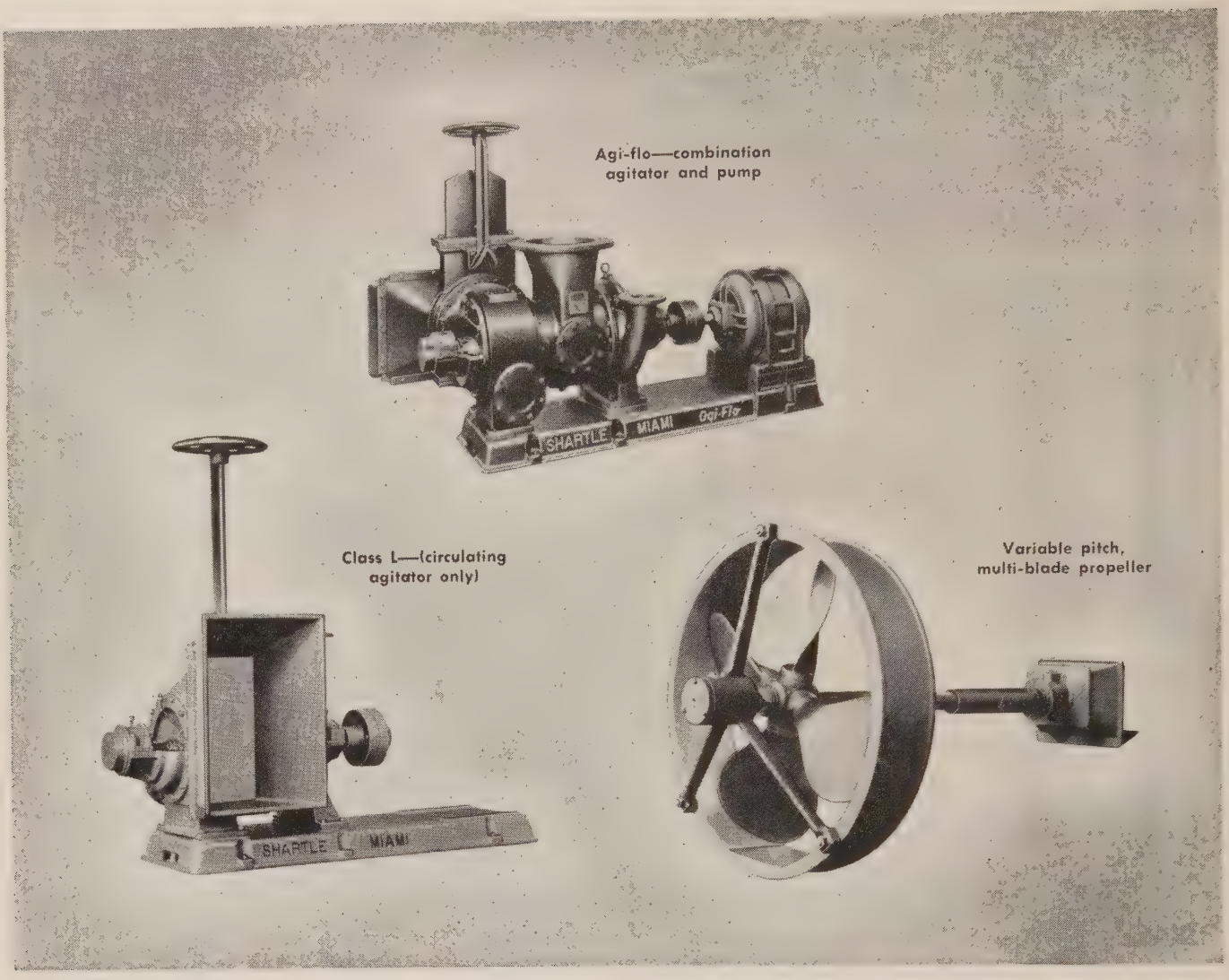

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There is no substitute for mill study when designing chests and agitators. Therefore, out of over half a century of wrestling with mill problems has come the Shartle line of agitating equipment suggested by the photos.

External agitation—Class L for agitation only; Agi-flo® combination agitator and pump.

Interior agitation—three and four blade variable pitch propellers; special propellers. Chest designs.

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for paper with plenty of fight

Effect of 2% Addition (Bleached Sulfite Stock)

HYDROSEAL will increase the Mullen, fold, tear, pick and tensile strength of your paper. It requires no preparation. It is a cold water swelling starch that is added directly to the beater in dry form.

HYDROSEAL improves formation and scuff resistance of the sheet, and improves greaseproofness of glassine. It cuts white water losses by increasing retention of fillers and fines, lays fuzz, and gives a better surface.

HYDROSEAL gives you better retention of starch in the sheet, too. And it's versatile — works in all types of paper from high grade bond and book papers to Kraft. For example, it improves the Mullen and formation of ledger paper and increases the flat crush of corrugating medium.

For further information about HYDROSEAL, or any one of National's complete line of starches and adhesives for the paper field, write —

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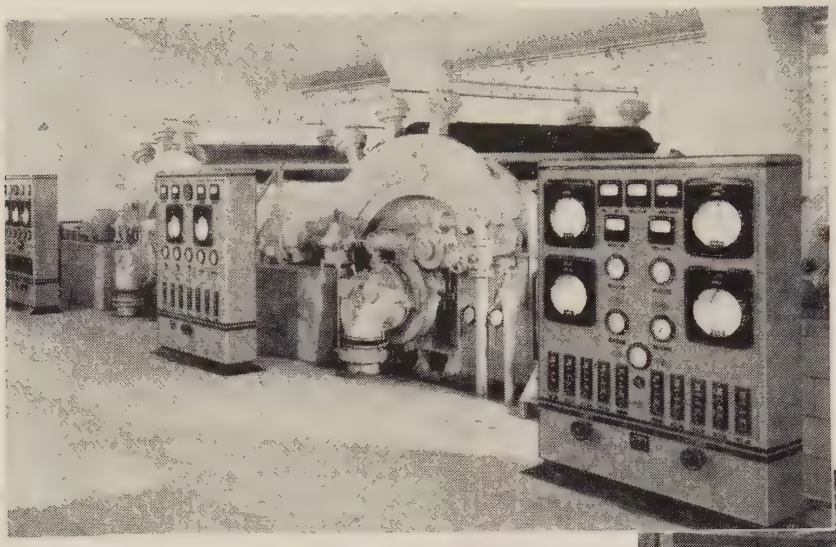
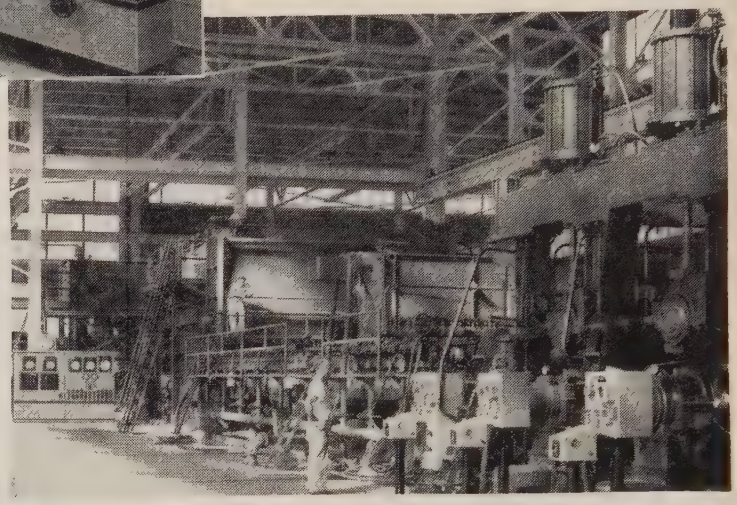


◀ *pH control in your bleach plant will improve quality and save chemicals.*

pH control on your paper machine will improve and maintain quality and permit higher machine speeds. ▼



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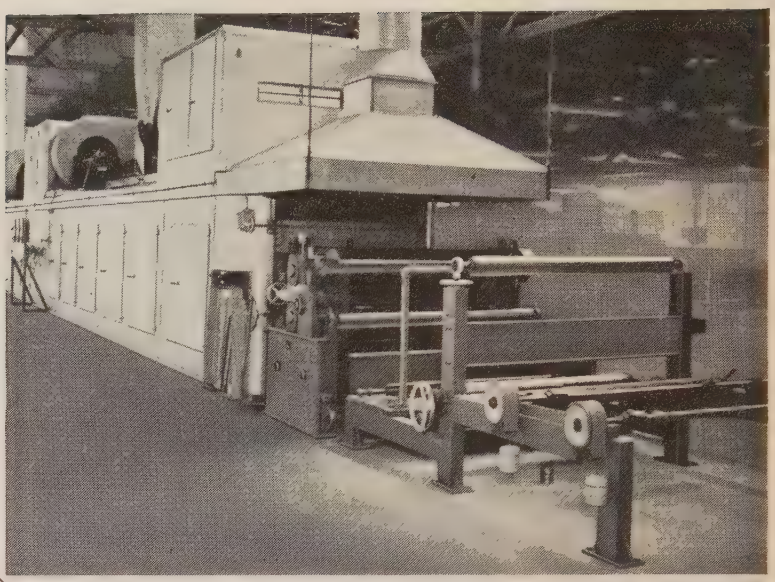

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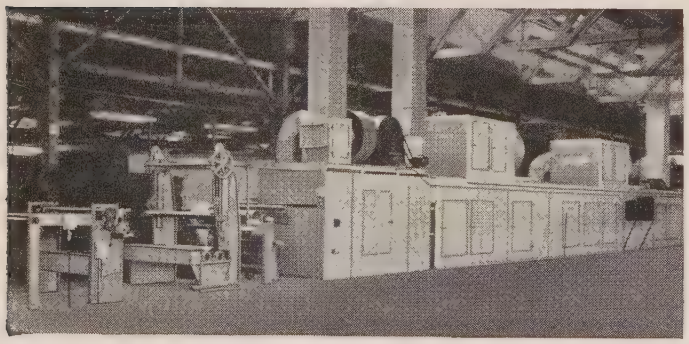

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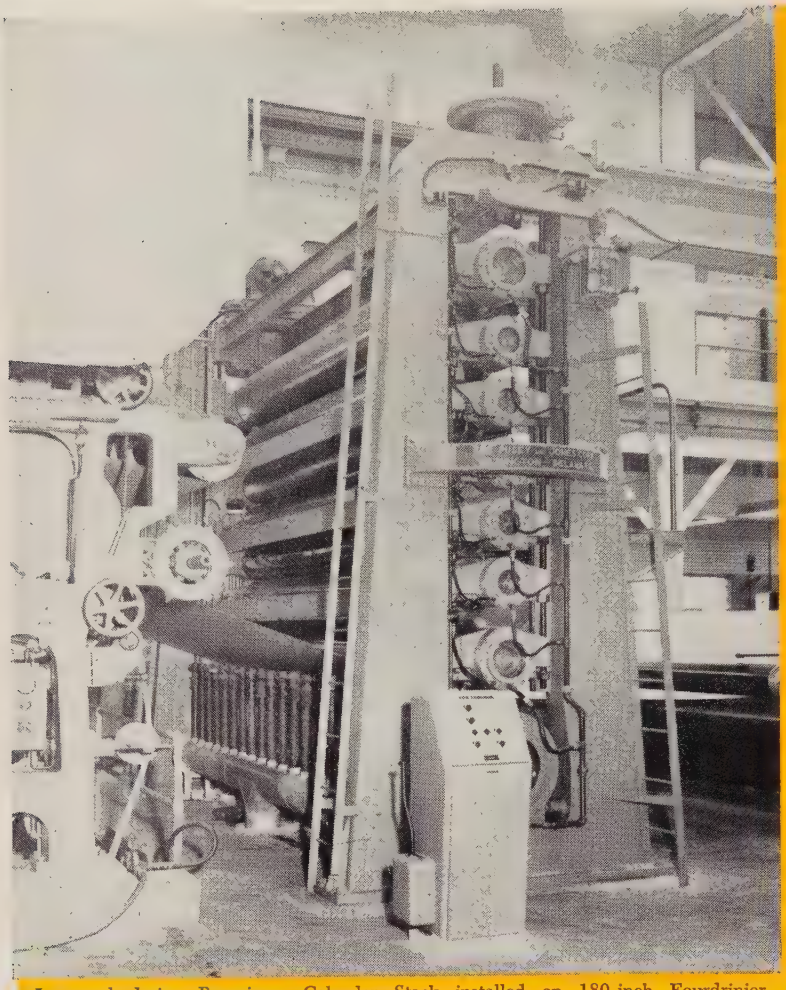

Improved design Puseyjones Calender Stack installed on 180-inch Fourdrinier Machine. Note the streamlined frames due to improvement in roll lifting mechanism.

Modernize with a new Puseyjones Calender Stack

Many mills are replacing worn-out stacks having plain bearings with modern equipment having all rolls mounted in anti-friction bearings . . . assuring better finish, higher speeds, lower maintenance cost and greater profits.

Main frames may be of heavy cast iron pattern or welded steel construction. Rolls may be of conventional chilled iron or higher grade alloy for longer wearing life and less regrinding. All roll bearings of heavy duty roller type lubricated by pressure feed oiling from an automatic circulating system. Bearing housings may be provided with Lucite observation windows. Air loading system for applying additional nip pressure.

In the latest Puseyjones Calender Stack, the lifting rods are located inside the frames on the same center line with the bearings, assuring uniform distribution of bearing loading when lifting the rolls by means of motor-operated mechanism. Latest flexible doctors may be used with pressure adjusted throw-off mechanism and motor-operated oscillating device for each doctor.

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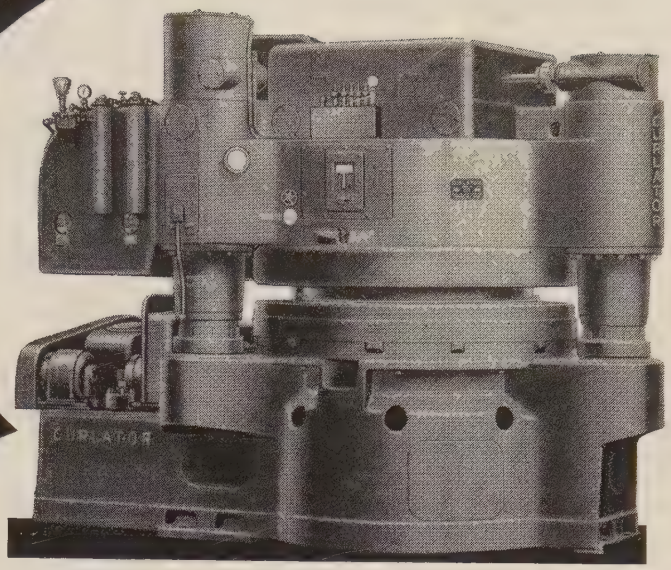

14 LEADING MILLS ARE NOW CURLATING THEIR PULP

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Oxyacetylene in Paper Mill Maintenance

DORSEY BLALOCK THOMAS

MAINTENANCE in paper mills, as in all other large manufacturing plants, plays a very important part in production. Without an efficient maintenance program no manufacturer can produce top quality products at competitive prices and continue to progress.

Oxyacetylene equipment is found in most maintenance departments. We have grown so accustomed to its presence in our shops that we sometimes overlook its value to us. However, I would hate to think of our plant trying to compete with other manufacturers without the use of this equipment.

The purpose of this discussion is to illustrate some of the uses we have found for oxyacetylene in such maintenance work as reclaiming material, hard-surfacing, and rebuilding production equipment. First, I would like to tell you a little about the operation of our plant to give a general idea of the type of maintenance that confronts us.

The Savannah, Ga., plant of Union Bag & Paper Corp. is the largest integrated pulp, paper, and kraft container operation in the world. Started in 1936 with one paper machine and a small bag factory, it now has five 236-in. paper machines with the necessary pulp-making equipment, a paper processing department, a by-products plant, a large bag factory, and a corrugated box plant. The bag factory produces enough bags every 4 days to provide one bag for each of the 150 million people in the United States.

A sixth paper machine of the same size is now being installed along with the necessary pulp facilities for this addition. This expansion will be completed by the Fall of this year. The anticipated production with this addition will be in excess of 1800 tons of finished paper and paperboard daily.

Over 200 loaded freight cars enter or leave our plant every day. These cars are used for delivering pulpwood, chemicals, and other supplies and for shipping finished products.

Lost time in our productive machinery is very expensive. For example, the production loss on a paper machine out of operation will range from 1000 to 1800 dollars per hour.

It is the responsibility of the maintenance department to keep the plant in good operating condition, making all repairs and replacements on pipe, tanks, machinery, pressure vessels, and structural steel. We also do a considerable amount of new construction.

Our maintenance department began its activities in 1936 with two oxyacetylene hand torches. There are now 90 hand torches in operation in various departments throughout the mill. This represents over a period of 17 years a total increase of 4400%. In addition, we have special equipment for powder cutting, flame hardening, flame priming, and metalizing; also ten portable cutting machines and one 3 by 10-ft. shape cutting machine. Last year 1,800,000 cu. ft. of oxygen and 500,000 cu ft. of acetylene were consumed.

In our extensive maintenance operations numerous problems are encountered, some of which have been eliminated with the aid of oxyacetylene equipment.

An average of 410 tons of pipe and pipe fittings is used annually for replacement and necessary alterations in the piping systems. Of this amount, about 20% can be reused if methods of salvaging are profitable.

The first five figures show how the reclamation of used tube turns has been accomplished with the use of a simple jig, a welding positioner, and a cutting machine. Figure 1 shows this operation. The tube turn mounted in the jig is 4 in. in diameter. This jig is adjusted to rotate the end of the tube turn being cut in a true radius at a desirable speed for good cutting. Even sizes this small can be salvaged at substantial savings. One mechanic and a helper can square

DORSEY BLALOCK THOMAS, Welding Instructor, Union Bag & Paper Corp., Savannah, Ga.

Fig. 1. Four-inch 90° tube turn

both ends of 62 tube turns this size in 8 hr. making perfect 90° ells that can be reused in most installations as new fittings.

Figure 2 shows a 12-in. tube turn mounted in the jig. In 8 hr., 35 of this size can be reclaimed. This jig handles sizes ranging from 4 to 14 in., making true 90° turns.

Figure 3 shows a jig for cutting true 45° turns ranging from 4 to 14 in. in diameter.

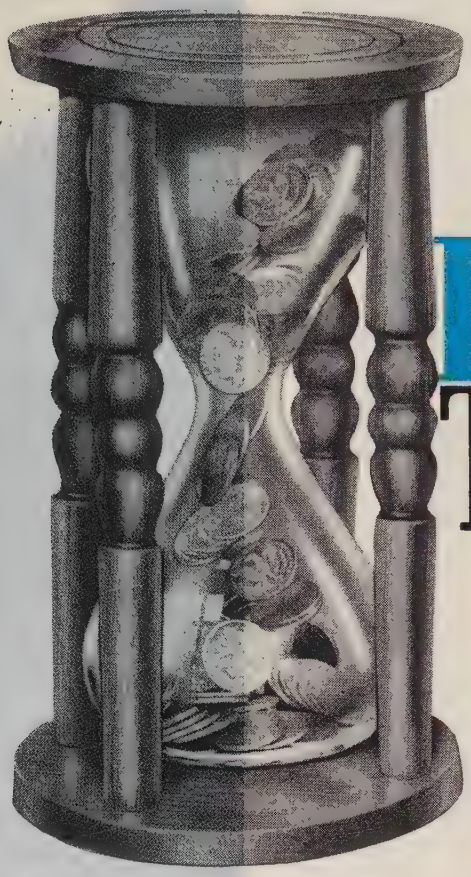
Figure 4 shows a jig that was designed to handle tube turns ranging from 16 to 36 in. in diameter. Mounted in the jig is a 20-in. tube turn being reclaimed.

Figure 5 shows an 18-in. stainless steel tube turn being reclaimed. The powder cutting attachment being used makes it possible to reclaim all types of stainless, Monel, and nickel fittings. The original cost of the stainless steel tube turn shown was 1500 dollars.

There were 950 tube turns of all sizes salvaged in 1952. After the cutting operation these fittings were cleaned in acid and dipped in a rust-preventive solution. They were then returned to the mill stores, to be used later in most installations as new tube turns. The original cost of the tube turns was 18,500 dollars. The complete salvage operation cost less than 3000 dollars. This left a net saving of more than 15,000 dollars on this salvage operation.

The development of the oxyacetylene procedure for hard-surfacing and overlaying has been of major importance in the economy of our maintenance operations. We have found some excellent applications for these methods of hard-surfac-

Fig. 2. Twelve-inch 90° tube turn



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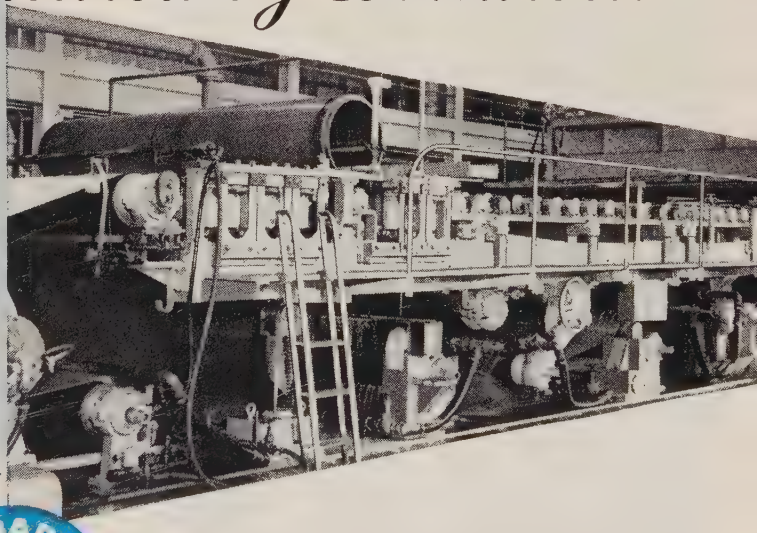

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Fig. 3. Eight-inch 45° tube turn

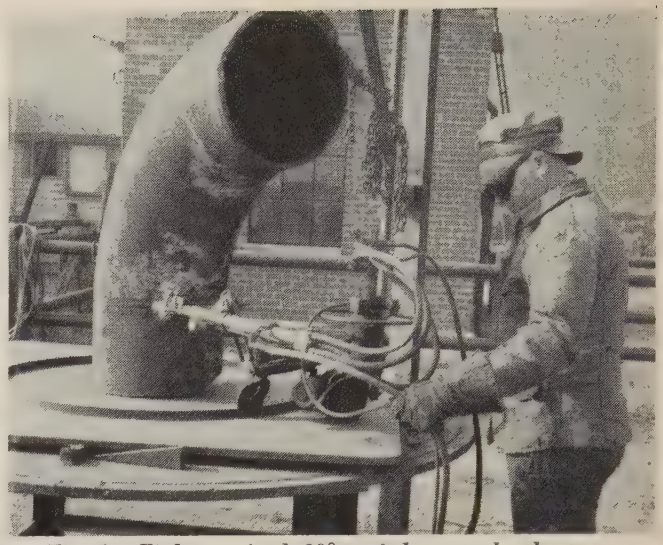

Fig. 5. Eighteen-inch 90° stainless steel tube turn

ing, such as on chipper bed plates, conveyor chains, wear plates, slitter knives, valve seats, and many others far too numerous to name at this time.

Figure 6 shows an automatic dumping valve used to wash pulp out of a tank 13 ft. in diameter and 30 ft. high. This valve is of foreign design and construction, and replacement parts are not readily available.

Figure 7 shows this valve in the open position spraying two streams of water under high pressure. The water loosens the pulp as the head rotates and the pulp flows out through the opening around the shaft. The head and seat of this valve are made of cast stainless steel.

Figure 8 shows this valve in the closed position. The head would close while turning, causing a galling or fretting action which occurs from the two similar metals rubbing together. These parts had a life span in some instances of only 30 days. The repair cost of removing, machining, and reinstalling this valve was over 500 dollars.

Figure 9 shows one of these valve heads being resurfaced by the oxyacetylene method. As an experiment one valve head was refaced with a nickel-base alloy. This head was placed in service in July, 1952, and is still operating perfectly. Since that time eleven more valves have been resurfaced. This operation has eliminated all lost time that was previously caused by the galling action on these valves.

Figure 10 shows a 3-in. stainless steel agitator shaft 13 ft. long. This shaft is used in a dissolving tank for mixing fused salt cake or sodium sulphate with weak liquor. The high temperature and the corrosive reactions of the chemicals in this operation made it almost impossible to find a suitable material for these shafts. The life of these shafts has been increased from 3 to 12 months simply by hard-surfacing the bearing journals with a cobalt-base alloy.

Figure 11 shows a jordan plug mounted in a lathe undergoing the oxyacetylene metalizing process. The brass sleeve being built up is 9 in. in diameter and 28 in. long. This has been found to be the only suitable method for building up this particular packing sleeve. All other methods require much higher temperatures which cause distortion in the shaft.

The process has proved to be most effective in the rebuilding of the various types of shafts in our plant. In many instances, through this metalizing procedure, a harder alloy is applied at the bearing journal than was used in the original material, consequently the repaired shaft will give longer service than was previously obtained. The rebuilding of the worn shafts represents a sizable saving in itself. However, much more important is the economy derived from keeping the production equipment in continuous service for a longer period of time.

Figure 12 shows a 2-in. stainless steel pipe being welded with the oxyacetylene method. A considerable amount of stainless steel pipe is used in our mill due to the extreme corrosive conditions. The oxyacetylene method is used for welding all small sizes of this pipe, primarily because all of our

Fig. 4. Twenty-inch 90° tube turn

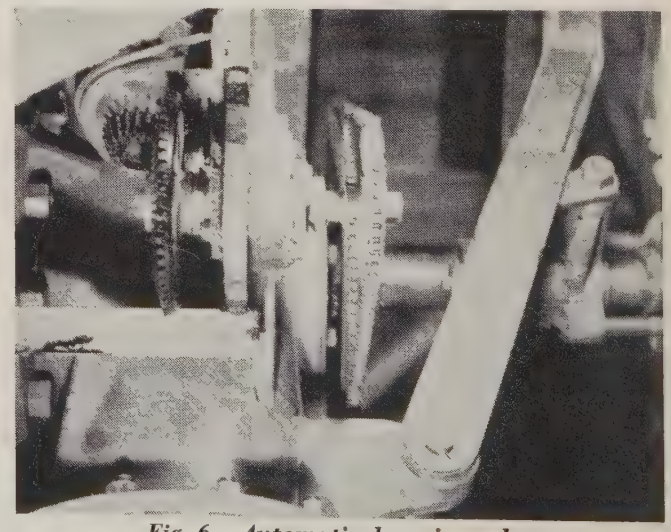

Fig. 6. Automatic dumping valve

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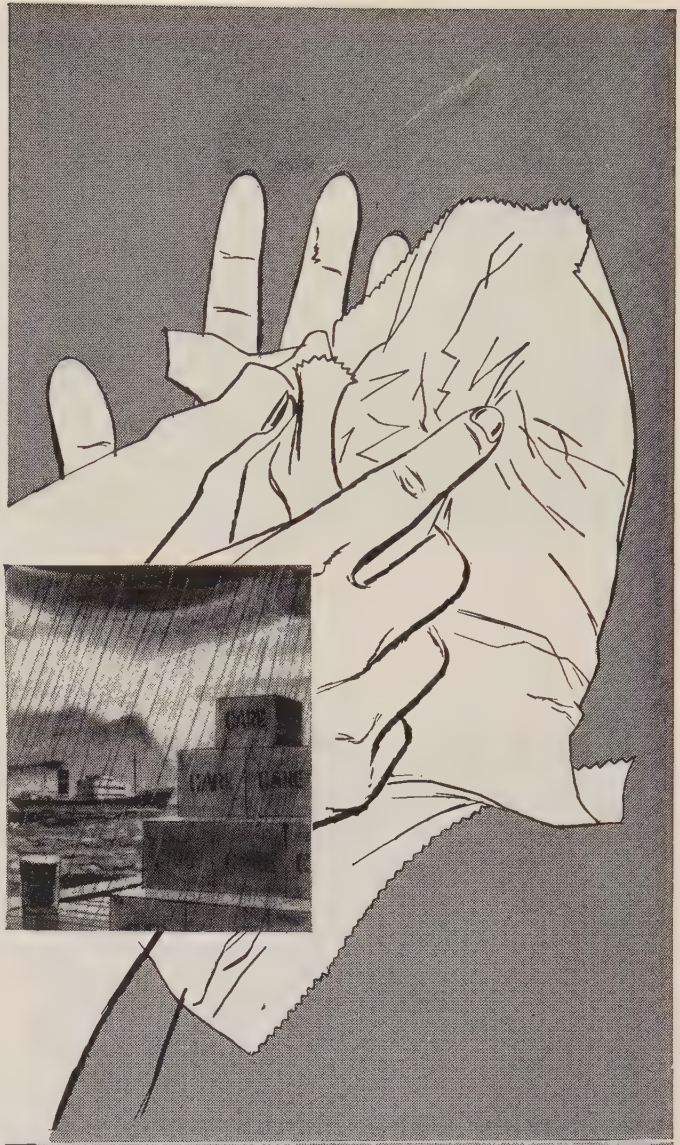
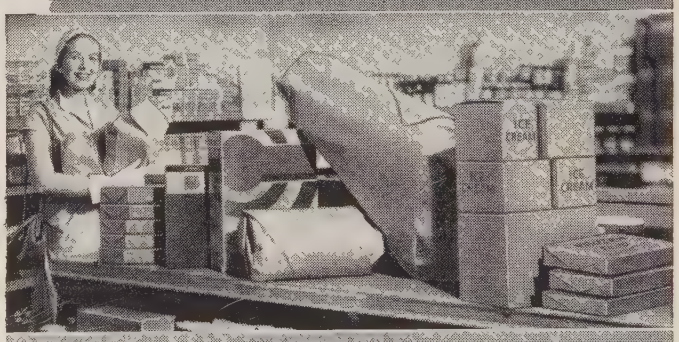


● Reichhold BECKAMINE P-682-35 is a *superior* wet strength resin for application to bleached and unbleached kraft or sulfite, ground wood, rag, or mixtures of these pulps. It increases dry tensile and Mullen strength . . . aids in the retention of clay, rosin size, starch, and other beater additives. A urea-formaldehyde resin of the cationic type, it can be diluted infinitely with water with no precipitation. BECKAMINE P-682-35 is usually applied after the refining operation at any convenient point, such as fan pump or headbox. If necessary, it can also be added at the beater. For complete information, please write for Technical Bulletin P-2.



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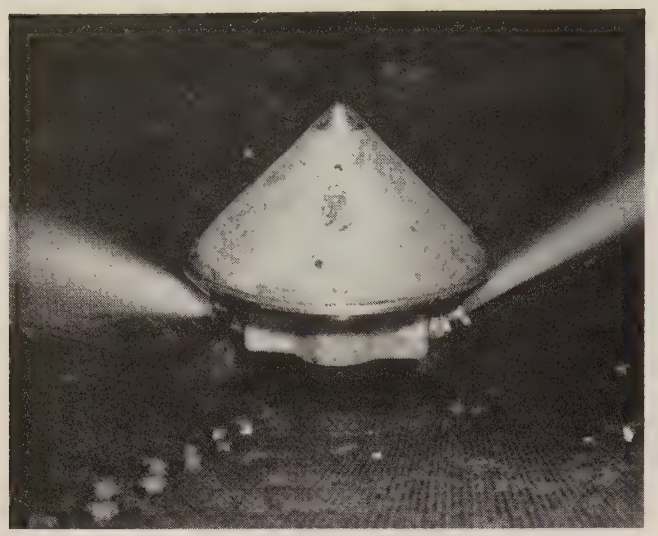

Fig. 7. Automatic dumping valve (open)

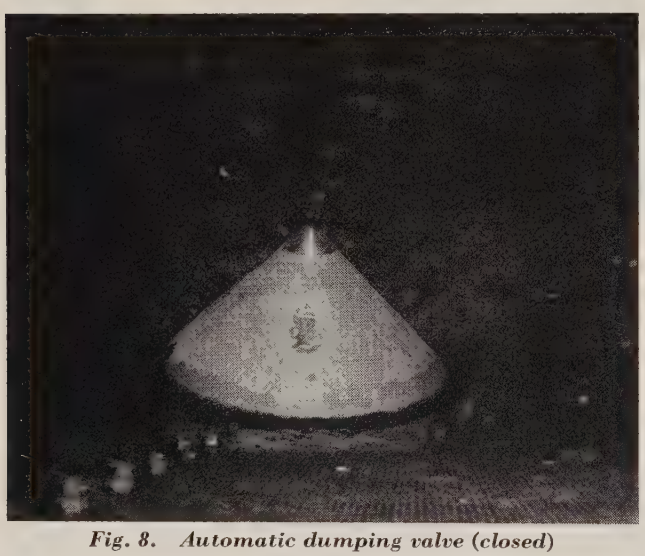

Fig. 8. Automatic dumping valve (closed)

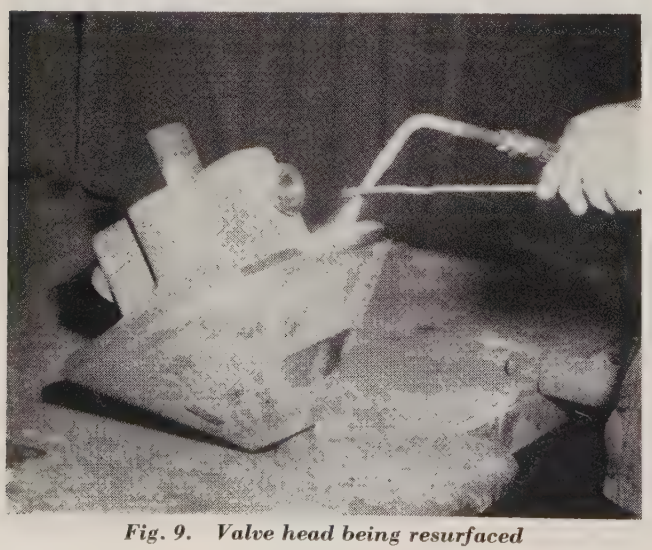

Fig. 9. Valve head being resurfaced

Fig. 10. Three-inch stainless steel shaft

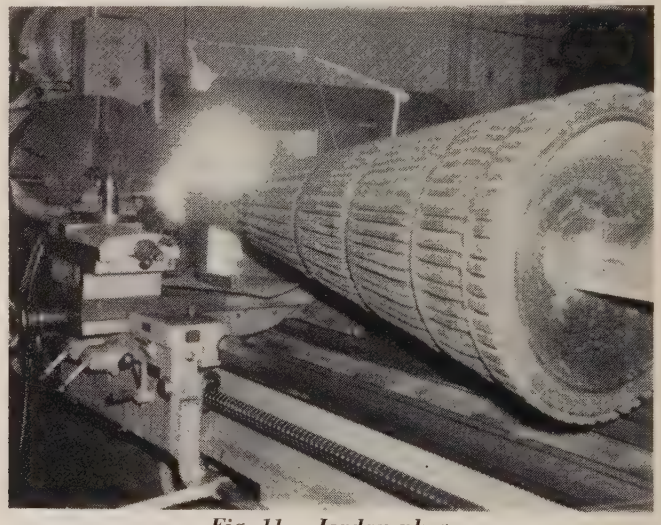

Fig. 11. Jordan plug

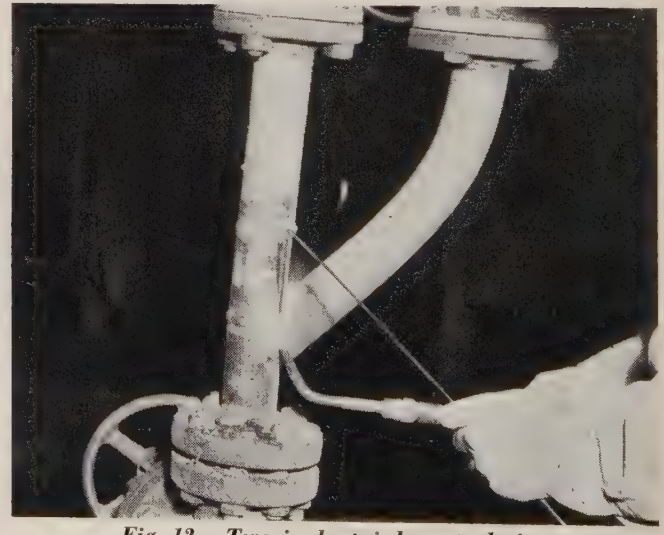

Fig. 12. Two-inch stainless steel pipe

welders are equipped with an oxyacetylene outfit. The simplicity and speed of this operation, together with the convenience of using this equipment in the many close places in which we work, give the oxyacetylene method a definite economical advantage over the other methods that give longer life. Figure 13 shows a number of these stainless steel pipes that were welded by this method.

Figure 14 shows a regular portable cutting machine equipped with a plate preparation attachment. This machine is cutting and beveling a $^1/_2$-in. plate. One hundred ninety-two plates prepared this way were used in the fabrication of 12 diffuser tanks for washing pulp. Without the use of this

ANOTHER E.D. Jones INSTALLATION

A new worm adjusting mechanism is featured in these 4 Jones Majestic Jordans at Weyerhauser's new board mill at Longview, Wash.

ANOTHER E.D. Jones INSTALLATION

These 5 Jones Majestic Jordans were part of the $15,000,000 expansion program at Hollingsworth & Whitney's Mobile, Ala., plant.

Majestic is the word for these Jordans

The Majestic is only one of the many sizes in which Jones Jordans are made. But such is the popularity of this high-capacity work horse that it accounts for 25% of the Jones Jordans sold to date. Like all Jones Jordans it incorporates exclusive features developed from our more-than-a-century of service to paper mills. For more details, ask your Jones representative or write for Bulletin 1007-A.

E.D. Jones

E. D. Jones & Sons Company, Pittsfield, Mass.

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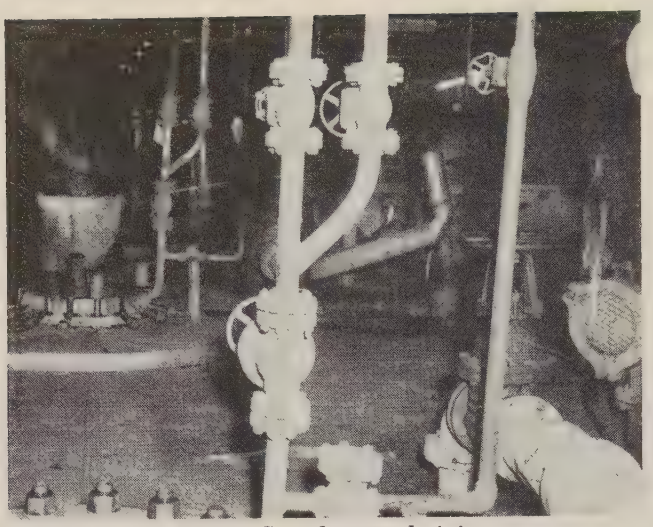

Fig. 13. Stainless steel piping

attachment two operations would have been required, one to square and one to bevel each edge. Twelve thousand three hundred feet of cutting was required for this particular job.

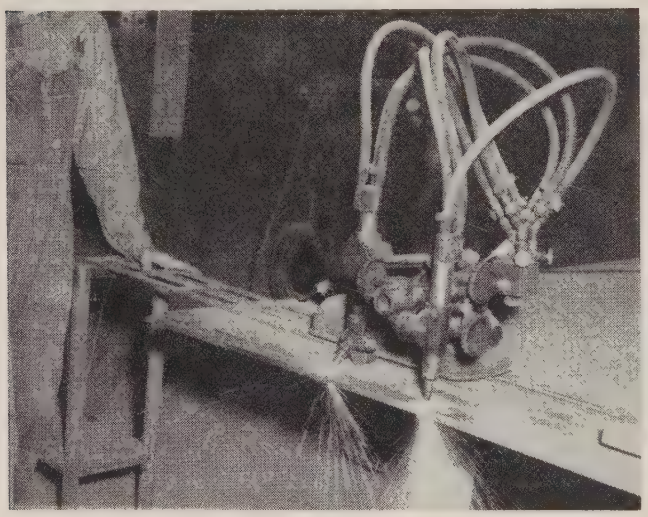

Fig. 14. Cutting machine

The use of this attachment reduced the cutting time 50%, saving about 175 man-hours. Figure 15 shows a number of these tanks after fabrication was completed.

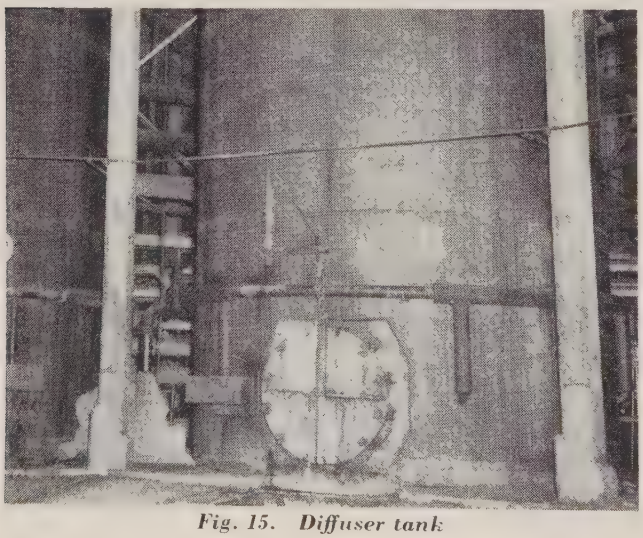

Fig. 15. Diffuser tank

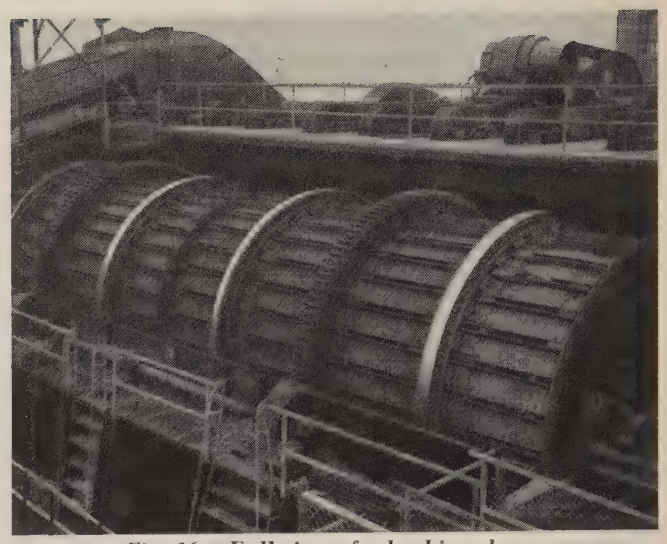

Fig. 16. Full view of a barking drum

Figure 16 shows a full view of a barking drum. We have six of these drums that require rebuilding periodically. Their function is that of removing the bark from the pine logs of the southern forests. This is the first operation in the manufacture of paper. No discussion of oxyacetylene usage in our plant would be complete without explaining the important part it plays and the enormous amount used in the rebuilding of these drums. Figure 17 shows a close-up of some of the welds and rivets in a barking drum. Approximately 3500 ft. of $1^1/_4$-in. weld and 2400 $1^1/_8$-in. rivets are used in rebuilding each of these drums. The mechanical shock caused from the tremendous load of wood being turned over in the drum cracks the welds and loosens the rivets. In rebuilding these drums the welds and rivets are removed by the use of hand torches equipped with large size wash and rivet cutting tips.

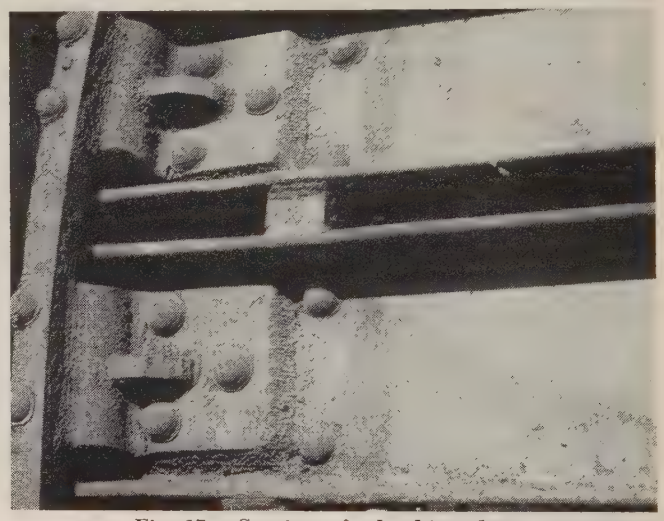

Fig. 17. Section of a barking drum

Approximately 12,500 cu. ft. of oxygen and 6000 cu. ft. of acetylene are consumed in rebuilding each of these drums.

The illustrations that have just been shown are a few examples of the numerous time and money saving uses found for oxyacetylene in maintenance work. It is our opinion that the oxyacetylene torch is one of the greatest time saving tools ever perfected. Without its availability the continued high standard of our maintenance operations would not be possible.

PRESENTED at a meeting of the International Acetylene Association, Atlanta, Ga., April 13–15, 1953.

Things are Looking up at Champion

—since they installed these INCONEL preheater tubes

FIRST TRIED in 1949, Inconel preheater tubes have proved so successful that the CHAMPION PAPER & FIBRE COMPANY now plans to install Inconel tubes in the remaining 14 preheaters at their Canton, N. C., mill.

Four years and one month . . .

That's how long it's been since the Champion Paper & Fibre Company installed a trial set of Inconel® tubes in a digester liquor preheater at their Canton, N. C., mill.

Like many mills, they'd been pushing equipment pretty hard to keep up with production schedules. And they kept up with the work, all right—but their preheaters showed the strain.

No wonder! They were going twenty-four hours a day, seven days a week without let-up. Inside the tubes — sulfate cooking liquor. Outside — pressurized steam at 354° F.

Ordinary tubes just couldn't take it. Twelve months and they were about done—corroded so badly they had to be scrapped.

It was in June, 1949, that Champion decided to try Inconel tubes in one preheater . . .

Today — more than four years later — *those Inconel tubes are still in use.*

But long life isn't their only advantage, as Champion has discovered. Inconel tubes also stay clean longer. They can be used almost six weeks between washings, while the old tubes needed a good cleaning out every three weeks. Saving that extra washing cuts cleaning costs in half, and in the time saved, Champion runs 17 more tons of pulp!

Champion is so pleased with the way this one preheater has served, that they're planning to re-tube the remaining 14 with Inconel.

Maybe you'd like to follow their lead. If so, it is advisable to place equipment orders, as approved by N.P.A., with your supplier well in advance of scheduled use. Distributors of Inco Nickel Alloys can supply the latest information on availability from warehouse and mill. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

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BETTER THINGS FOR BETTER LIVING... *THROUGH CHEMISTRY*

Sulphite Digester Heater Tube Cleaning Survey—1952

W. R. BARBER, JR., and JOHN M. WILCOX

THE variables affecting sulphite pulp mill operation are so many and so complex that very frequently superintendents are not able to operate equipment such as digester circulating and indirect heating systems without excessive calcium sulphate scale formation. At the February, 1952, TAPPI meeting it was suggested to the Acid Pulping Committee that a questionnaire be prepared and sent out to sulphite mills throughout the country in an effort to correlate operating conditions with heater tube scaling and cleaning methods.

In 1951 a sulphite mill located in the Pacific Northwest experienced severe and sudden failure of their digester heater tubes after the heaters had been in operation a comparatively short time. From the day these heaters were started up, there was excessive calcium sulphate scale formation in the tubes and quite drastic cleaning methods were employed. Because of the suddenness and severity of this failure, a complete study of the cleaning method and the nature of the tube failure was made. It was found that the tubes had failed from stress corrosion after being cleaned two or three times with a sharp pointed, chisel-shaped tool. This cleaning tool had severely scratched and gouged the inside surface of the tubes, setting up stresses which caused complete failure through pinhole leaks.

The authors visited other sulphite pulp mills in the Pacific Northwest to study their operations, particularly in those mills that had been successfully using digester heaters for many years. It was learned that about half the mills had given up the use of cleaning tools and were soaking their scaled-up tube bundles in warm 50% caustic. This soaking, which might last from 2 or 3 days to a week, softened up the scale to the point where it could be removed easily with a stiff wire brush. This type of cleaning can be most successfully used before the scale has accumulated too extensively but is not practical when the tubes are completely plugged.

The mills still using mechanical tube cleaning methods are careful to see that the tube walls are not gouged or stressed from this operation. However, examination of heater tubes which had failed in service over a period of years disclosed that, although the final failure was from chemical corrosion, there were indications of stress corrosion also being present to some degree which no doubt hastened the complete failure. In other words, mechanical cleaning methods used in past years have been causing some stress corrosion problems which have not been recognized.

In June of 1952, the Technical Association of the Pulp and Paper Industry mailed out a questionnaire to 91 sulphite pulp mills and received 53 replies. The form of the questionnaire was as shown below:

TAPPI Acid Pulping Committee
Sulphite Digester Heater Tube Cleaning Survey

1. Do you use tubular indirect digester heaters? _____ Yes. _____ No.

If your answer above is "Yes," please answer the following questions as completely as possible. Replies will be coded at the New York TAPPI office before the data are sent to committee members for the preparation of a report, so the identity of the individual mills will be unknown.

2. How often are heater tubes cleaned? _____ mos.
3. Are tubes cleaned mechanically? _____ Yes. _____ No.
   (a) Using drills? _____
   (b) Using reamers? _____
   (c) Using wire brushes?
   (d) Using rattler-type tube cleaner? _____
   (e) Other? _____
   (f) Brief description _____
4. Are tubes cleaned chemically? _____ Yes. _____ No.
   (a) Using acid? _____
   (b) Using caustic? _____
   (c) Other? _____
   (d) Brief description _____
5. Average length of service of tubes before replacement? _____ yr.
6. Why do tubes fail?
   (a) Pitting under scale? _____
   (b) Loose in tube sheets? _____
   (c) Crack next to tube sheets? _____
   (d) General over-all corrosion? _____
   (e) Damage from mechanical cleaning? _____
   (f) Due to steam impingement? _____
   (g) Other? _____
7. Tube data: Size _____ in. O.D. Wall thickness _____ gage. Length _____ ft. _____ in. Number of tubes each heater _____
   Are heaters single-pass? _____ or two-pass? _____
8. Circulating rate:
   At start _____ g.p.m. At 4th hr. _____ g.p.m.
   At 1st hr. _____ g.p.m. At 5th hr. _____ g.p.m.
   At 2nd hr. _____ g.p.m. At 6th hr. _____ g.p.m.
   At 3rd hr. _____ g.p.m. At 7th hr. _____ g.p.m.
9. When is circulating pump shut off? After _____ hr.
10. What is average digester temperature?
    At start _____ °C. At 4th hr _____ °C.
    At 1st hr. _____ °C. At 5th hr. _____ °C.
    At 2nd hr. _____ °C. At 6th hr. _____ °C.
    At 3rd hr. _____ °C. At 7th hr. _____ °C.
11. What is steam temperature? _____ °F. and pressure? _____ p.s.i.g.
12. TAPPI permanganate number of pulp cooked? _____
13. Cooking acid: Free _____ %. Combined _____ %.
14. Type of acid:
    (a) Calcium-base _____ (c) Magnesium-base _____
    (b) Ammonia-base _____ (d) Sodium-base _____
15. Sulphates in cooking acid expressed in per cent calcium sulphate by weight? _____ %.
16. Total solids in digester blow liquor expressed in per cent by weight? _____ %.
17. Pounds of combined SO_2 manufactured per 100 lb. of moisture-free wood loaded to digester? _____ lb. This is the ratio of combined SO_2 to wood in the cooks.
18. Temperature of the acid pumped to the digesters? _____ °C.
19. Is the digester cooking acid pumped to the digester from storage pumped through the heater en route to the digester? _____ Yes. _____ No.
20. Remarks _____

Of the 53 replies, only 13 reported using digester heaters. Some of the reports from mills not using heaters partially answered the questions, and a few of these gave interesting comments. In Table I are tabulated the results from the 13 mills using heaters, numbered from 1 to 13, inclusive. Also tabulated are reports from 11 mills not using heaters, marked A to K, inclusive.

The reply from mill 1, which reports cleaning their tubes every 2 months, commented as follows: "Drilling done by Tilden Rotary Konkrete Kore drill with four Carboloy tips. Tips are so ground to avoid side cutting and consequent damage to metal. . . . Slow heating of deposit in tubes converts gypsum to anhydride. This can be accomplished at a low temperature with warm dry air passing through tubes. However, the time involved makes it prohibitive."

The reply from mill 2, which reports cleaning their tubes every 2 to 4 months, commented as follows: "Tubes are turbined with a power tool and drill which is about $^1/_{64}$ in. smaller than tube inside diameter. . . . A 25% caustic soda has been circulated through the tubes at 220 to 230°F. This has been

W. R. BARBER, JR., and JOHN M. WILCOX, Electric Steel Foundry Co. (ESCO), Portland, Ore.

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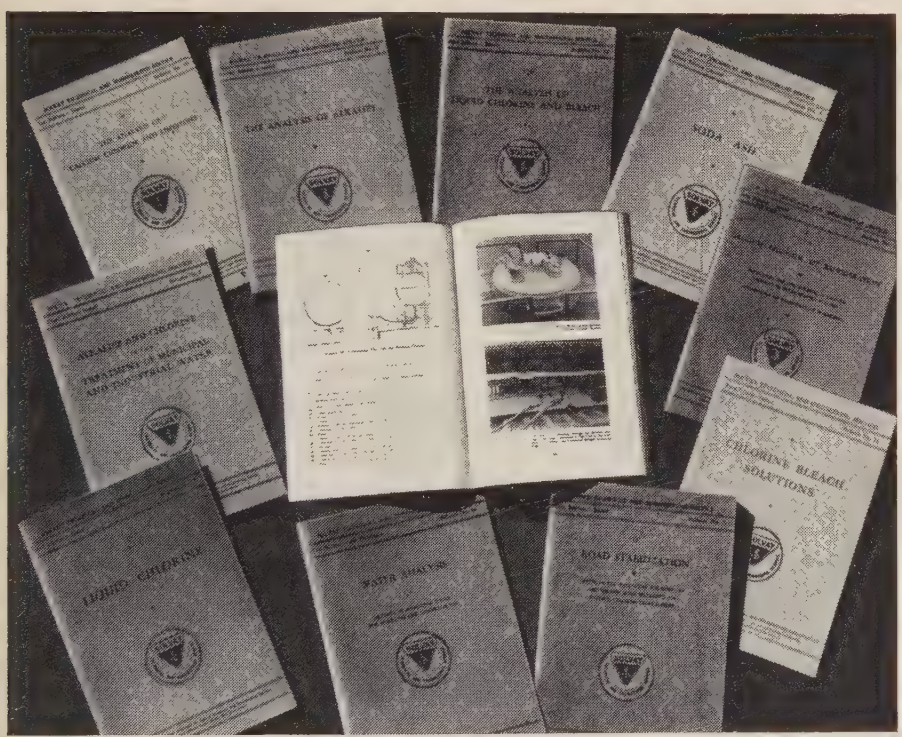

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NAME_____

ORGANIZATION_____

ADDRESS_____

CITY_____ ZONE_____

STATE_____ SN-7

Mill	1	2	3 Mech.	3a	3b	3c	3d	3e	4a	4b	4c	5	6a	6b	6c	6d	6e	6f	7 Size, in.	7 Wall	7 Length, ft.-in.	7 Number of tubes	7 Mat'l.	7 Dbl. or Sgl.	8 Start	8 1st hr.	8 2nd hr.	8 3rd hr.	8 4-7hr.
1	Yes	2 mo.	Yes	Yes	..	..	Yes	..	No	No	No	14	..	Yes	Yes	..	Yes	..	$1^1/_8$	10 ga.	11-0	110	T-316	Dbl.	2400	2400	2400	Unk.	2400
2	Yes	2–4 mo.	Yes	Yes	No	No	No	No	No	Yes	No	1–3	Yes	No	No	No	..	No	$1^1/_2$	15 ga.	10-9	52	T-316	Dbl.	1360	1140	1140	1140	1140
3	Yes	Never	No	No	No	No	No	No	No	No	No	10	Yes	Yes	No	No	Yes	No	$1^1/_2$	15 ga.	16-0	44 55	T-316	Sgl.		Pump rating, 2600 g.p.m.			50-ft. hd.
4	Yes	1 mo.	Yes	No	Yes	No	No	No	No	No	No	15	No	No	No	No	Yes	No	$1^1/_2$	$^1/_{16}$ in.	11-$5^5/_8$	56	T-316	Dbl.	1800	1800	1800	1800	1800
5	Yes	4 mo.	No	No	No	No	No	No	No	Yes	No	6	Yes	No	Yes	No	No	No	$1^1/_4$	15 ga.	10-6	?	T-316	Dbl.	3600	3600	3600	3400	2800 1800 0 0
6	Yes	$2^1/_2$ wk.	Yes	Yes	No	No	No	No	No	Yes	No	5[a]	Yes	No	No	No	No	No	$1^1/_4$	15 ga.	14-0	144	T-316	Dbl.		No meters			
7	Yes	Never	No	No	No	No	No	No	No	No	No	3[a]	No	No	No	No	No	No	1	16 ga.	14-0	124	T-316	Sgl.	3800	3000	3000	3000	3000
8	Yes	$2^1/_4$ mo.	Yes	Yes	No	Yes	No	No	No	No	No	10	No	No	No	No	Yes	No	$1^1/_8$	$^1/_{16}$ in.	11-6	?	T-316	Dbl.		1600 g.p.m.			
9	Yes	1 mo.	Yes	Yes	No	No	No	No	No	No	No	4[a]	No	No	No	No	No	No	1	0.062 in.	15-0	193	T-316	Sgl.		3000 g.p.m.			
10	Yes	2 mo.	Yes	Yes	No	No	No	No	No	No	No	8	No	No	No	No	Yes	No	$1^1/_2$	15 ga.	10-$9^1/_8$	4–44 1–106	T-316	Dbl.		1200 g.p.m.			
11	Yes	1–2 mo.	Yes	Yes	No	No	No	No	No	No	No	1	No	No	No	No	Yes	No	$1^1/_4$	15 ga.	12-6	98	T-316	Dbl.	1780	1780	1780	1750	1740
2	Yes	3 yr.	Yes	Yes	No	Yes	No	No	No	No	No	3	Yes	No	No	No	Yes	No	$1^1/_4$	15 ga.	16-0	84	T-316	Dbl.	1050	1100	1100	1100	1020 900 580 420
13	Yes	6 mo.	Yes	No	Yes	Yes	No	No	No	No	No	6	No	No	Yes	No	Yes	No	1	16 ga.	8-0	192	T-316	Dbl.		1500 g.p.m.			
A	..	...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	...	...	..	...	..	..	..	..	..	..
B	..	...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	...	...	..	...	..	..	..	..	..	..
C	..	...	.	.	.	.	.	.	..	..	..	..	..	..	..	..	..	..	..	...	...	.	...	.	..	..	..	.	..
D	..	...	..	..	.	.	.	.	..	..	..	..	..	..	..	..	..	..	..	...	...	.	...	.	.	.	..	..	..
E	..	...	.	..	.	.	.	.	..	.	..	..	..	..	..	..	..	..	..	...	...	.	...	.	..	..	..	.	..
F	..	...	.	..	..	.	.	.	..	.	..	..	..	..	..	..	..	..	..	...	...	.	...	.	.	..	..	..	..
G	..	...	.	.	..	..	..	..	..	.	..	..	..	..	..	..	..	..	..	...	...	.	...	.	.	..	..	..	..
H	..	...	.	..	..	..	..	..	..	.	..	..	..	..	..	..	..	..	..	...	...	.	..	.	2200	..	2800	.	..
I	..	...	.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	...	...	.	..	.	..	..	..	..	..
J	..	...	..	..	.	.	.	.	..	..	..	..	..	..	..	..	..	..	..	...	...	.	..	.	..	..	..	..	..
K	..	...	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	...	...	.	..	.	..	.	..	.	..

[a] Not yet replaced. [b] 100% magnesium-base acid. [c] Roe chlorine number.

found to soften the scale considerably and makes turbining easier but does not completely remove scale."

The reply from mill 3, which reported no scale formation in their heater tubes, commented as follows: "The best way to clean heater tubes is to reverse the process that limed them up in the first place. . . . The liming of heaters is caused by improper operation. For a given mill system, we believe that a way can be found to run heaters without liming troubles. We feel that if there is one factor that is basically wrong in most installations, it is the velocity through the tubes. Pumps are too small, heaters have too many tubes, and steam temperatures are too high."

The reply from mill 4, which reported cleaning their tubes once a month, commented as follows: "We use a reamer of our own design, slightly smaller than the inside diameter of the tubes. . . . Complete replacement made after 15 years of service. Some of the tubes needed replacement before then."

The reply from mill 5, which reported cleaning their tubes every 4 months, commented as follows: "50% NaOH is used at about 180°F. for at least 4 days. A water soak after draining is sometimes used."

The reply from mill 6, which reported cleaning their tubes every $2^1/_2$ weeks, commented as follows: "Wilson pneumatic tube cleaners are used to remove scale after tube bundle has been soaked overnight in 50% sodium hydroxide solution at 200°F. Twelve tubes replaced in 5 years."

Mill 7, which reported that they do not clean their heater tubes, is a 100% magnesium-base sulphite mill which has been in operation approximately 3 years.

The reply from mill 8, which reported cleaning their tubes every $2^1/_2$ months, commented as follows: "If lime is heavy, a hollow point drill with a water stream is used, followed by a spiral steel wire brush. Both rotate with 1200 r.p.m. air motor."

The reply from mill 9, which reported cleaning their tubes once a month, commented as follows: "Electric drill with extension on bit. Drill from top. Pressure weight of drill."

The reply from mill 10, which reported cleaning their tubes every 2 months, commented as follows: "Air operated tube cleaner with 14-ft. by $^7/_8$-in. shaft is hung with rope blocks directly above vertical tube bundle. A carbide-tipped cutter bit attached to the shaft can be lowered into the tube as the cleaning progresses."

The reply from mill 11, which reported cleaning their tubes every 1 to 2 months, commented as follows: "Use air-operated two-man drills, with cooling water running through tube. Plan to change to chemical cleaning with caustic soda . . . . We are considering increasing the combustion chamber capacity and also improving the gas recovery system. Smaller drills will be used for cleaning tubes if caustic soda does not prove satisfactory."

The reply from mill 12, which reported cleaning their tubes after 3 years of operation, commented as follows: "Scaling of heat exchangers due to using high sulphate content well water in acid plant. Scale very fast growth—soft, easily scratched with fingernail."

The reply from mill 13, which reported cleaning their tubes every 3 months, made no special comments. They did indicate that their tubes were replaced after 5 years' service because of cracking next to the tube sheet and damage from mechanical cleaning.

The reply from mill A stated only that they are using Hydro Heaters.

The reply from mill B stated that their digesters are equipped with Chemipulp forced circulation systems, using Hydro Heaters, on sodium-base acid. They commented, "Conversion to sodium-base has eliminated, for all practical purposes, the formation of calcium sulphate and, as a result, there should be no problem in keeping indirect heaters clean. However, the lack of a protective coating of calcium sulphate in the 316 stainless steel has resulted in increased corrosion of acid, relief, and stock piping. We are of the opinion, backed by experience while on calcium-base acid, that adding steam through the Hydro Heater formed troublesome calcium sulphate. Elimination of the Hydro Heater, but continuing the circulating system without it, did away with the sulphate formation in the mill."

The reply from mill C commented, "We do not have forced circulation or a heater. We have a two-stage Chemipulp system on precirculation."

Mill D commented, "Digesters are equipped with direct steaming circulating systems. It is seldom we have any lim-

Sulphite Digester Heater Tube Cleaning Survey

9	10								11		12	13		14				15	16	17	18	19	
	Start	1st hr.	2nd hr.	3rd hr.	4th hr.	5th hr.	6th hr.	7th hr.	Steam temp., °F.	Steam press., p.s.i.g.		Free, %	Combined, %	Ca	NH_4	Mg	Na				Temp., °C.		Mill
10	50	60	75	82	102	110	112	112	300	125	8–9	5.38	1.12	Yes	No	No	No	0.060	11–13	...	10–20	No	1
At end	70	95	104	117	136	139	139	139	352	125	10–12	4.50	1.12	Yes	No	No	No	0.125	12–14	4.7	60	Yes	2
At end	..	..	85	102	115	124	130	135	310	50	10–11	4.00	1.30	Yes	No	No	No	0.120	9.0	...	35	No	3
$6^1/_2$	35	75	105	130	138	136	134	132	400	115	12	5.0	1.0	Yes	No	No	No	0.084	12.0	4.4	30	No	4
5	75	84	108	116	128	138	136	134	298	50	10–11	7.0	1.0	Yes	No	No	No	0.100	13	0.044	75	No	5
$4^1/_2$–5	..	100	112	126	135	140	139	...	350	115	...	5.2	1.10	Yes	No	No	No	0.130	11	4.9	75	No	6
$4^1/_2$	..	87	113	134	137	...	...	...	385	125	13	8.2	1.1	No	No	Yes	No	1.300[b]	17	0.04	75	No	7
$5^3/_4$	30	71	100	123	137.7	137.7	137.7	137.7	350	140	16	5.7	1.3	Yes	No	No	No	0.120	13	5.70	30	50%	8
At blow	75	85	100	112	120	125	127	129	485	130	16	4.86	1.22	Yes	No	No	No	0.120	14.2	2.04	85	No	9
7	50	74	97	115	128	137	144	137	350	120	10	5.0	1.0	Yes	No	No	No	0.050	13	9.7	30	Yes	10
$5^1/_2$–6	66	74	99	124	135	138	138	135	350	125	13–14	6.60	1.20	Yes	No	No	No	0.125	15	5.67	60–62	No	11
8	36	90	115	130	135	...	...	...	..	120	12–16	4.80	1.20	Yes	No	No	No	0.080	...	4.8	30	No	12
At blow	40	70	90	105	118	128	140	145	353	125	...	4.30	1.15	Yes	No	25%	No	0.060	12.4	4.1	30	No	13
.....	..	..	..	..	...	...	...	...	..	..	...	..	..	..	..	..	..	....	...	...	...	..	A
.....	..	60	90	108	120	130	135	140	435	125	10	7.00	1.00	No	No	No	Yes	?	12.0	4.87	60	No	B
.....	90	100	110	120	130	135	139	142	450	125	350[c]	6.50	0.90	Yes	No	No	No	0.020	12.0	5.0	90	No	C
.....	..	..	..	..	...	...	...	...	..	..	...	..	..	..	..	..	..	....	...	...	...	..	D
.....	..	..	..	..	...	...	...	...	..	..	...	5.50	1.20	Yes	No	No	No	....	...	...	28	..	E
.....	..	..	..	..	...	...	...	...	..	..	...	..	..	..	..	..	..	....	...	...	...	..	F
.....	70	84	96	109	118	127	133	136	340	100	8–10	4.75	1.00	Yes	No	No	No	0.09	...	3.4	70	No	G
$5^1/_2$	85	..	..	..	...	...	140	...	460	140	17–22	5.35	1.15	Yes	No	No	No	....	...	...	85	No	H
.....	..	..	..	..	...	...	...	...	..	..	...	..	..	..	..	..	..	....	...	...	...	..	I
.....	..	..	..	..	...	...	...	...	..	..	...	..	..	..	..	..	..	....	...	...	...	..	J
$4^1/_2$	74	102	124	133	136	136	135	129	390	125	12.4	6.18	1.22	Yes	No	No	No	0.16	12.5	5.5	77	No	K

ing in the combining tubes but, if this does occur, the combining tube is removed between cooks and the deposits chipped out."

Mill E commented, "We are using circulating systems cold. No heaters .... I used heaters for years and, generally speaking, I would not use heaters again. They are terribly expensive and there is no quality gain advantage, in my opinion."

Mill F commented, "Our digesters are all direct cooking. We also use Chemipulp hot acid circulating system. We will appreciate a copy of the report as we are very much interested in indirect cooking as our boiler returns are very low."

Mill G commented, "While we do not use indirect heaters on our digesters, we do use Chemipulp Hydro Heaters and circulating systems and, at one time, had considerable trouble with scale, both in the smaller acid lines, valves, strainers, and fittings. A 'Rotojet' cleaner was found very good on circulating system. Since reducing sulphates to their present amount, lime scale has practically disappeared."

Mill H commented, "Circulating, but use no heaters." This mill manufactures newsprint sulphite from hemlock and white fir mixed woods.

Mill I stated that they had Rosenblad heat exchangers on order to be installed in September.

Mill J commented, "We have heating coils in the digesters which are washed daily with water as the stock is dumped and which do not otherwise require cleaning."

Mill K made no special comments.

After studying Table I, it is believed that almost everyone will agree that there are so many variables involved that it is well-nigh impossible to set up any general rules for keeping calcium base heater scale to a minimum. It is fairly apparent that almost everyone reporting has a scaling problem of some magnitude. Although the report from mill 3 stated that their heater tubes were never cleaned, they also indicated that their tubes failed from three causes—namely, pitting underneath scale, coming loose from tube sheets, and damage from mechanical cleaning. This is obviously contradictory.

It is possible that some of the mills using heaters who did not answer the questionnaire are not having as much scale trouble as those who did answer. The authors' company alone has installed digester heaters in 12 sulphite pulp mills in the United States. Taking into account the heaters supplied by other manufacturers, there must be *many* more mills using heaters than the 13 mills whose answers are tabulated in Table I, who all had scale trouble to some extent. Thus, if more answers had been received, variables might have shown up that would have indicated what factors are most important in controlling heater scale.

For several years now, certain factors have been recognized as affecting heater tube scale. The better known of these are: (1) liquor velocity in tubes, (2) high per cent combined as compared to free in acid, (3) superheated or high temperature steam, (4) high temperature rise through heater, (5) impurities in water supply, (6) inside smoothness of tube, (7) impurities in raw acid, and (8) presence of copper in the acid system.

From those completely answering the questionnaire, it is noted that their heater tube velocities average around 12 f.p.s., which has been a figure more or less accepted by the industry as a minimum velocity to be used if excessive scaling is to be avoided. Responses from mills 9, 12, 13 are considerably under 12 f.p.s., and this could be contributing to their rate of scale formation. High velocity alone, within reasonable limits, will probably not prevent scale formation if other contributory factors are present.

There are possibly other contributory factors to scale formation in addition to the eight listed above, and these might vary from mill to mill. It is obvious that each mill should work toward eliminating all factors before they can hope to get optimum results. If this is done, it is believed that maintenance can be cut down in most of the mills, thus eventually effecting substantial savings.

For example, the per cent sulphates in the acid could have a marked effect on scale formation. Also, the concentration of chloride ions could effect stress corrosion. There are not sufficient data to evaluate these conditions among different mills. It is hoped the mills themselves will continue to look for further answers, so that eventually the whole industry may benefit.

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The assistance of J. M. McEwen and E. H. Woodruff, past Chairman and present Chairman, respectively, of the TAPPI Acid Pulping Committee is greatly appreciated. The authors also wish to thank National TAPPI for assistance in mailing out the questionnaires and collecting the answers.

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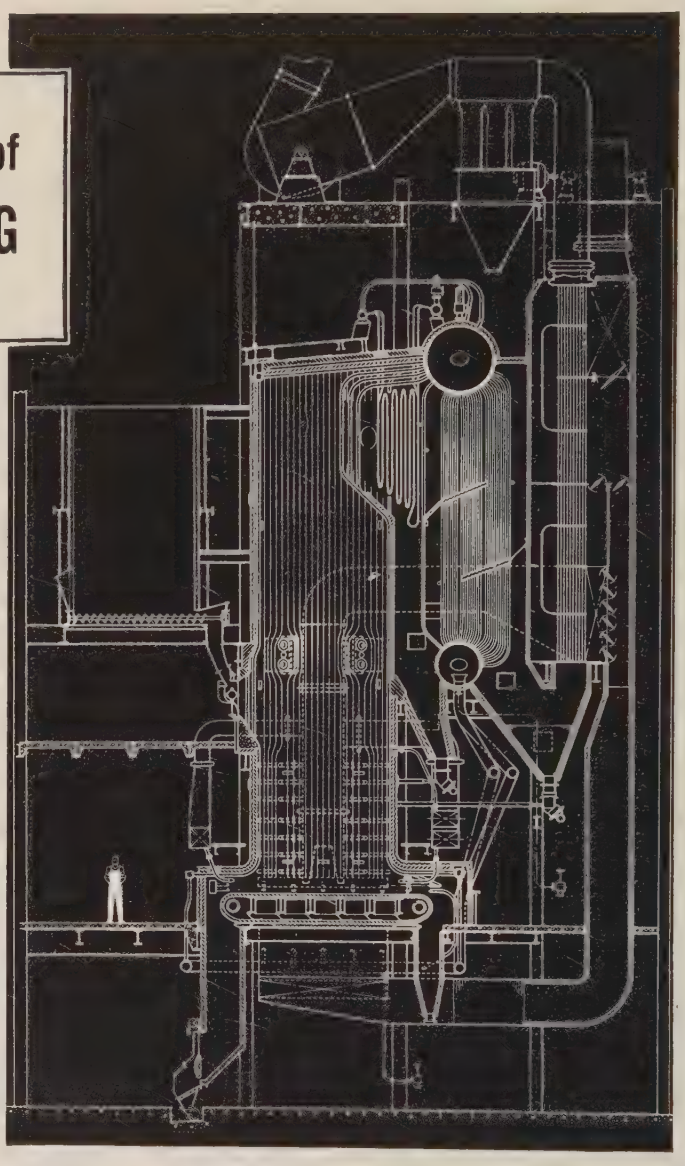

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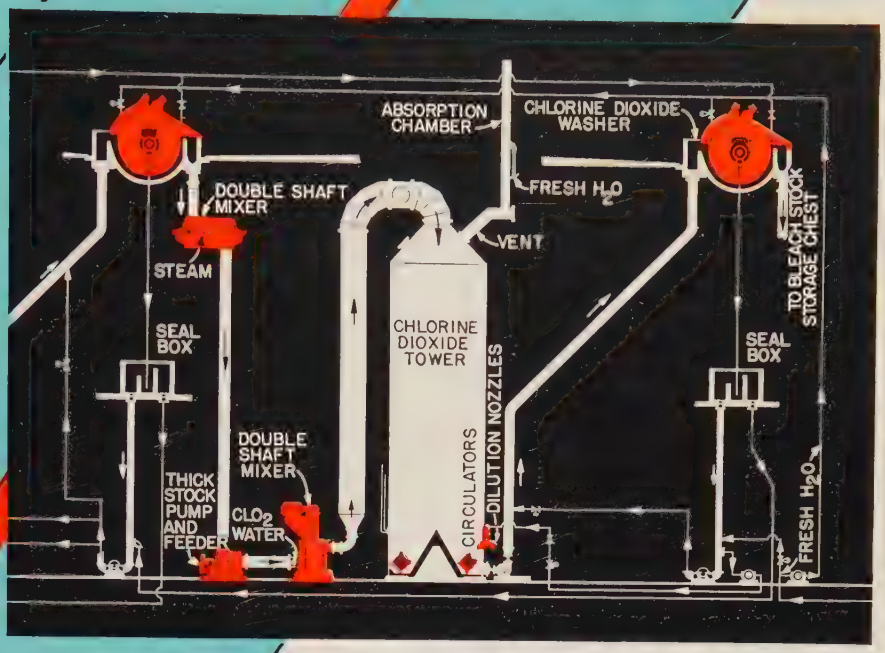

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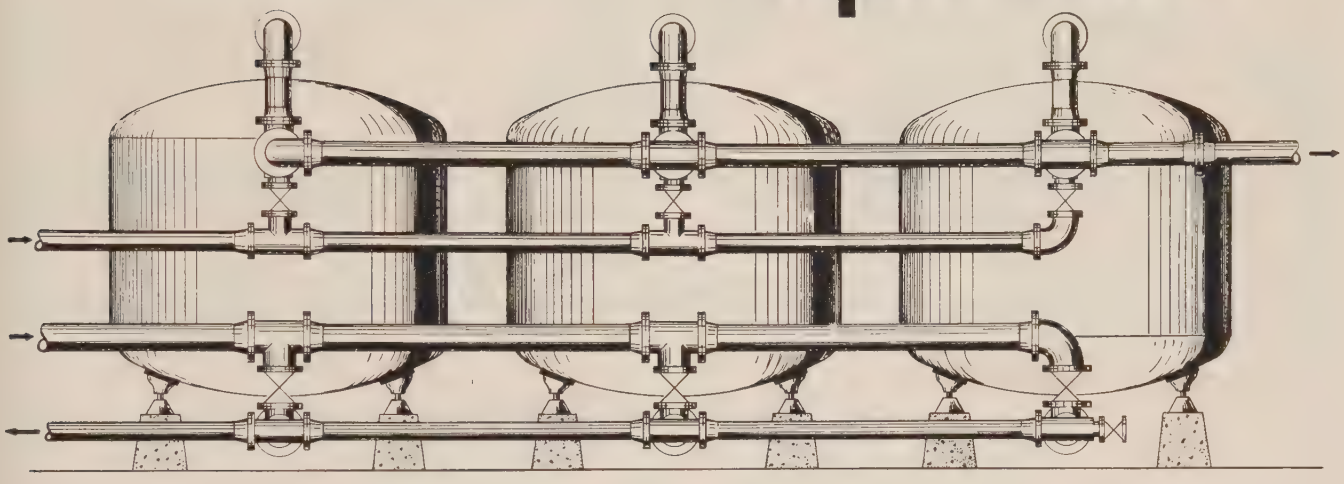

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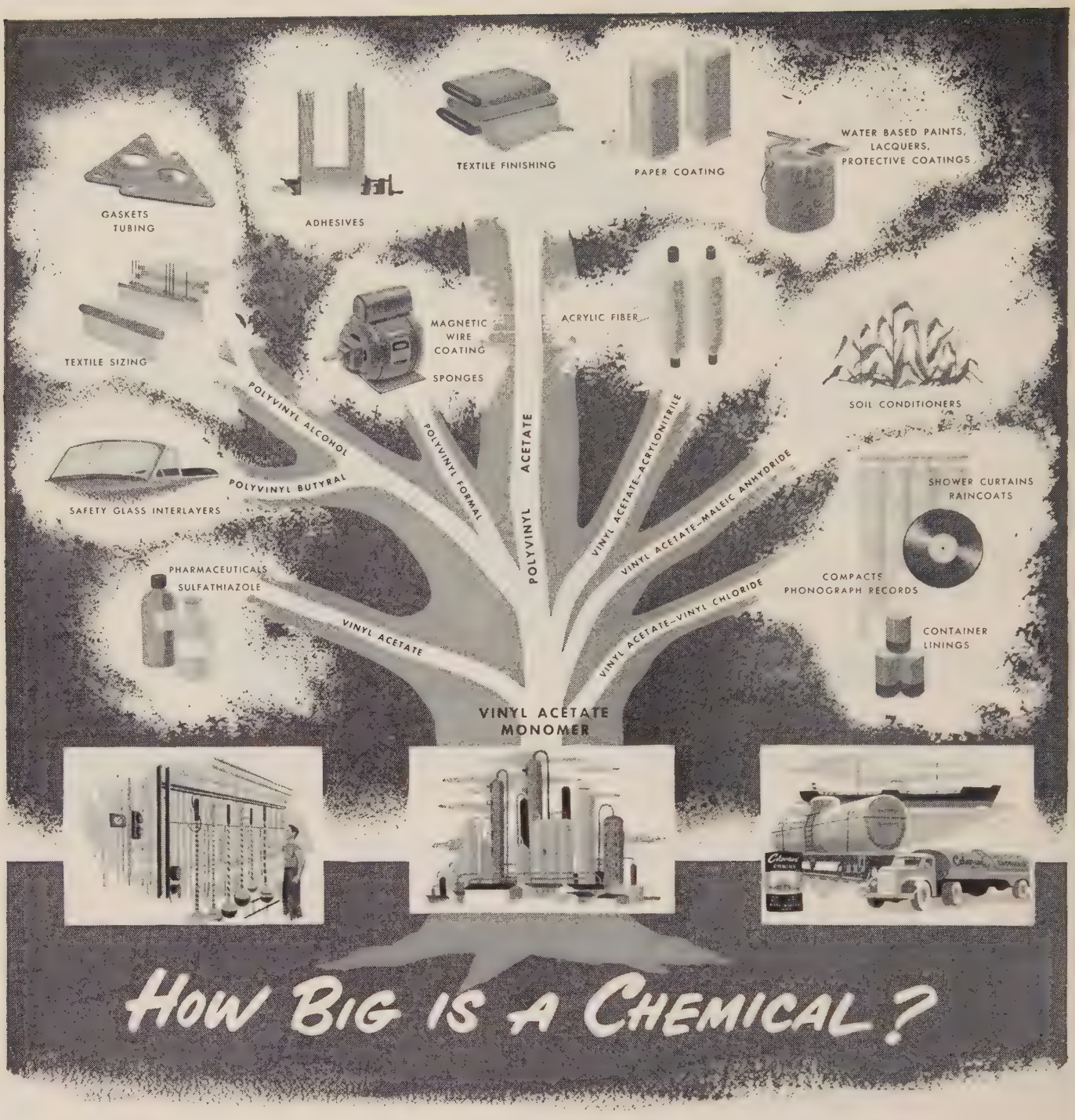

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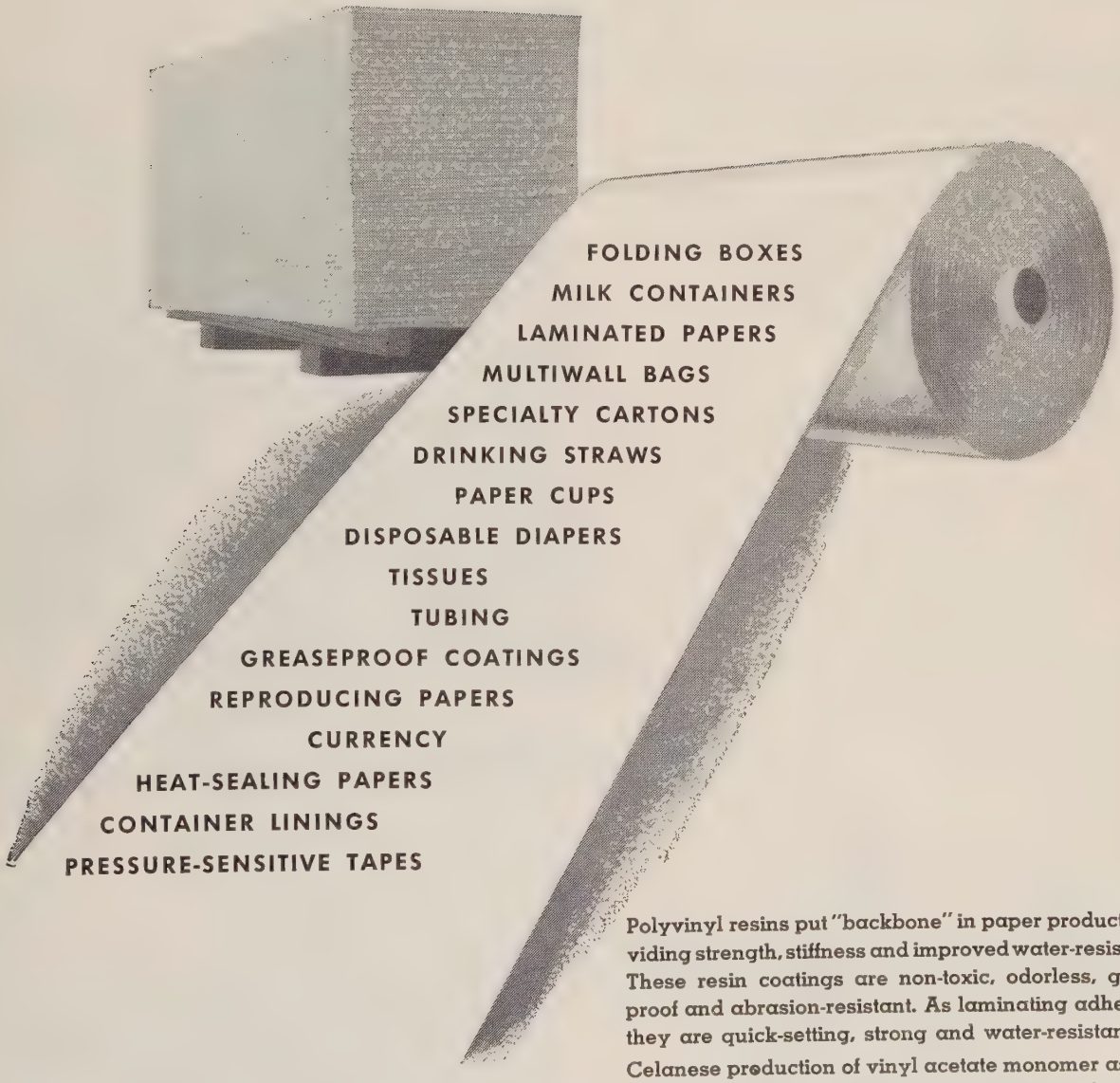

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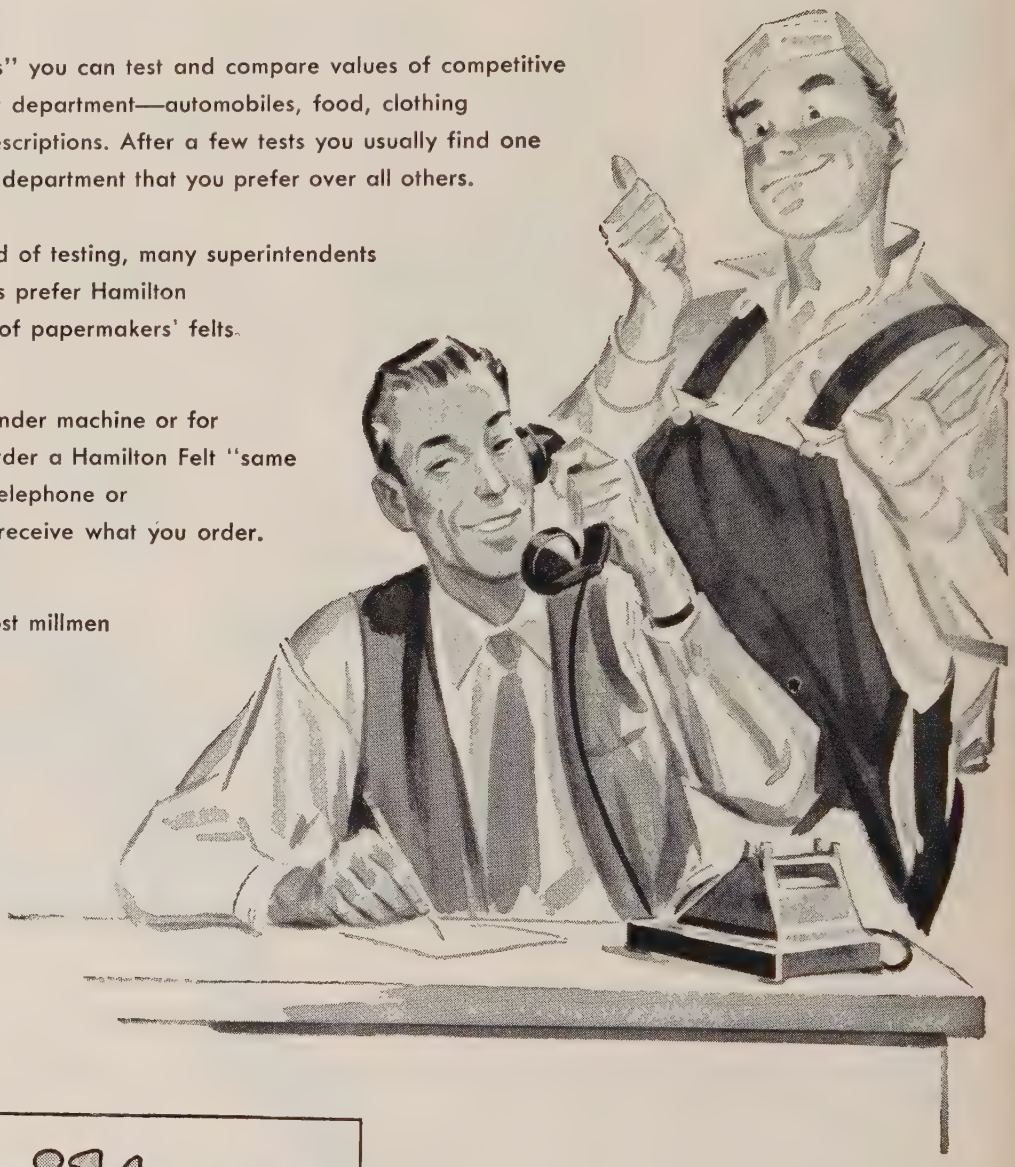

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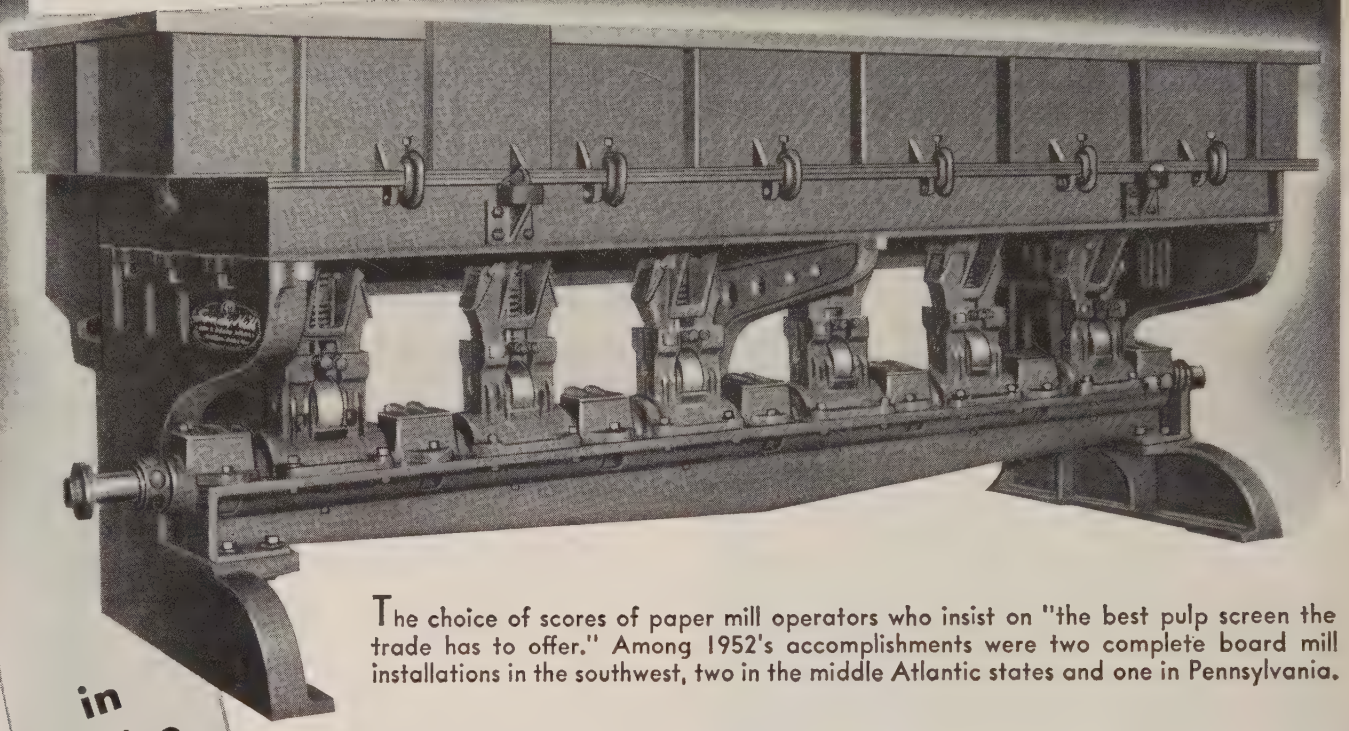

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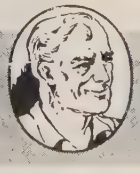

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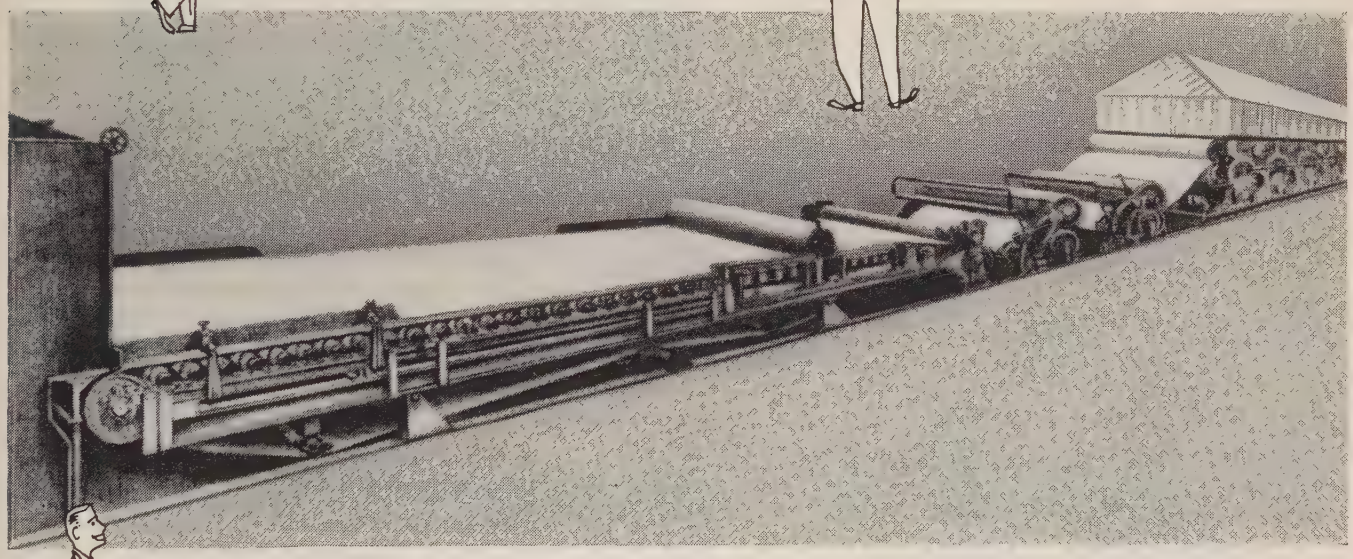

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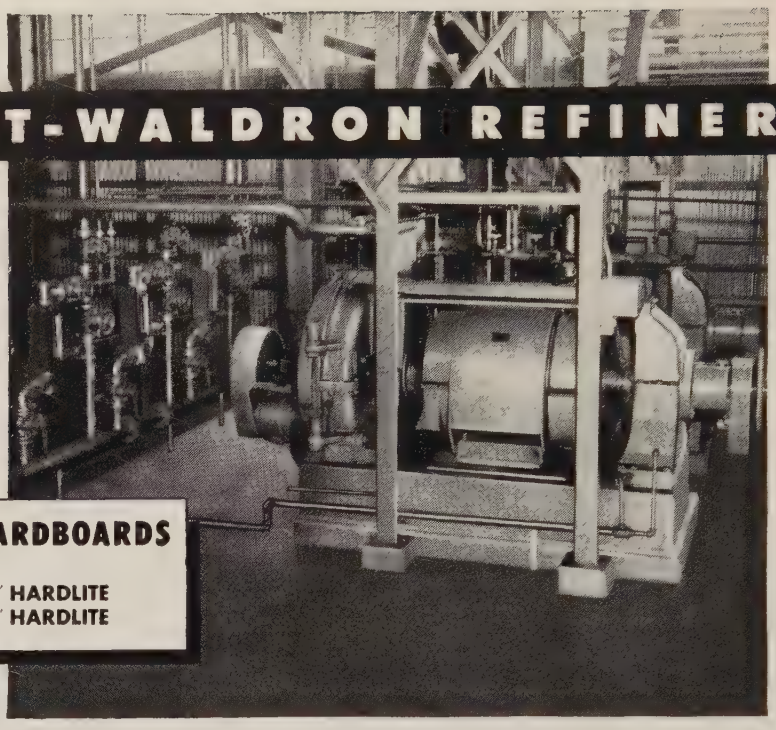

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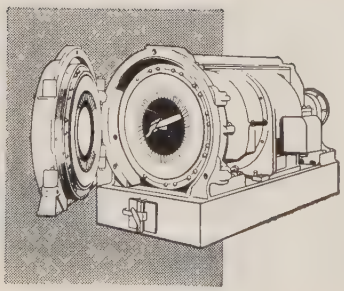

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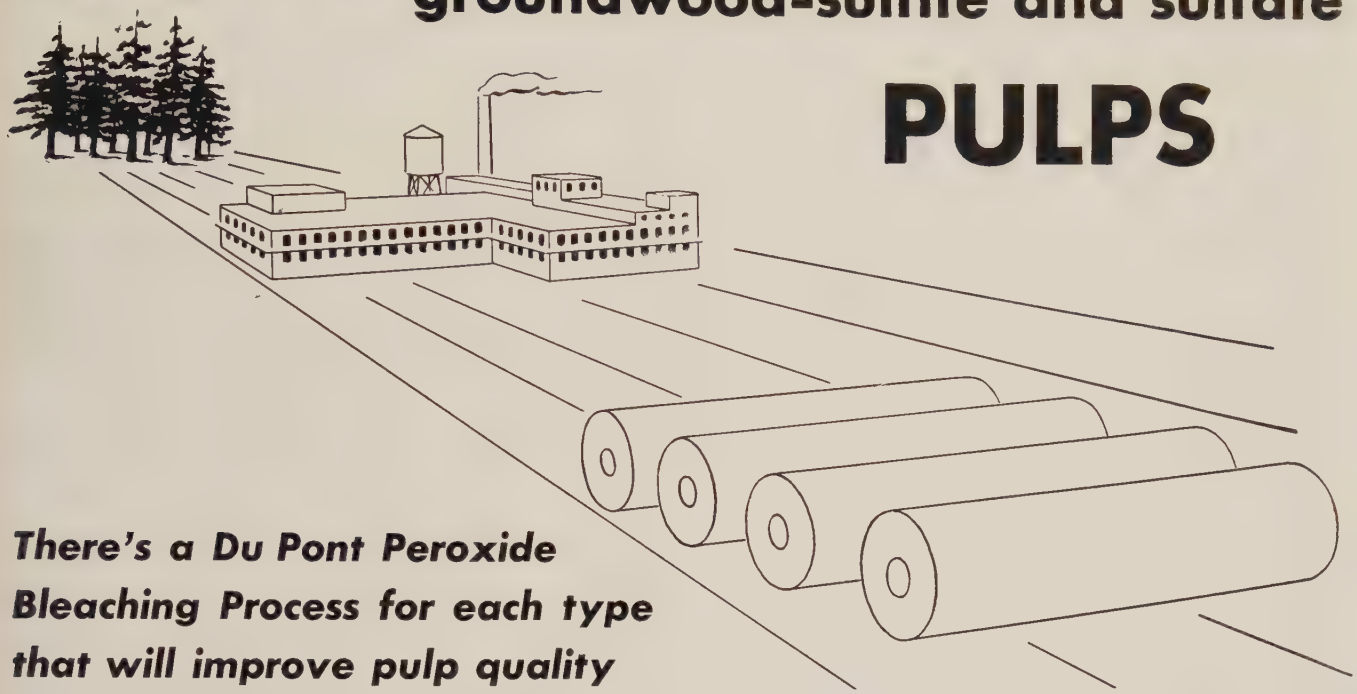

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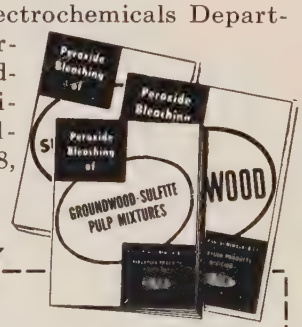

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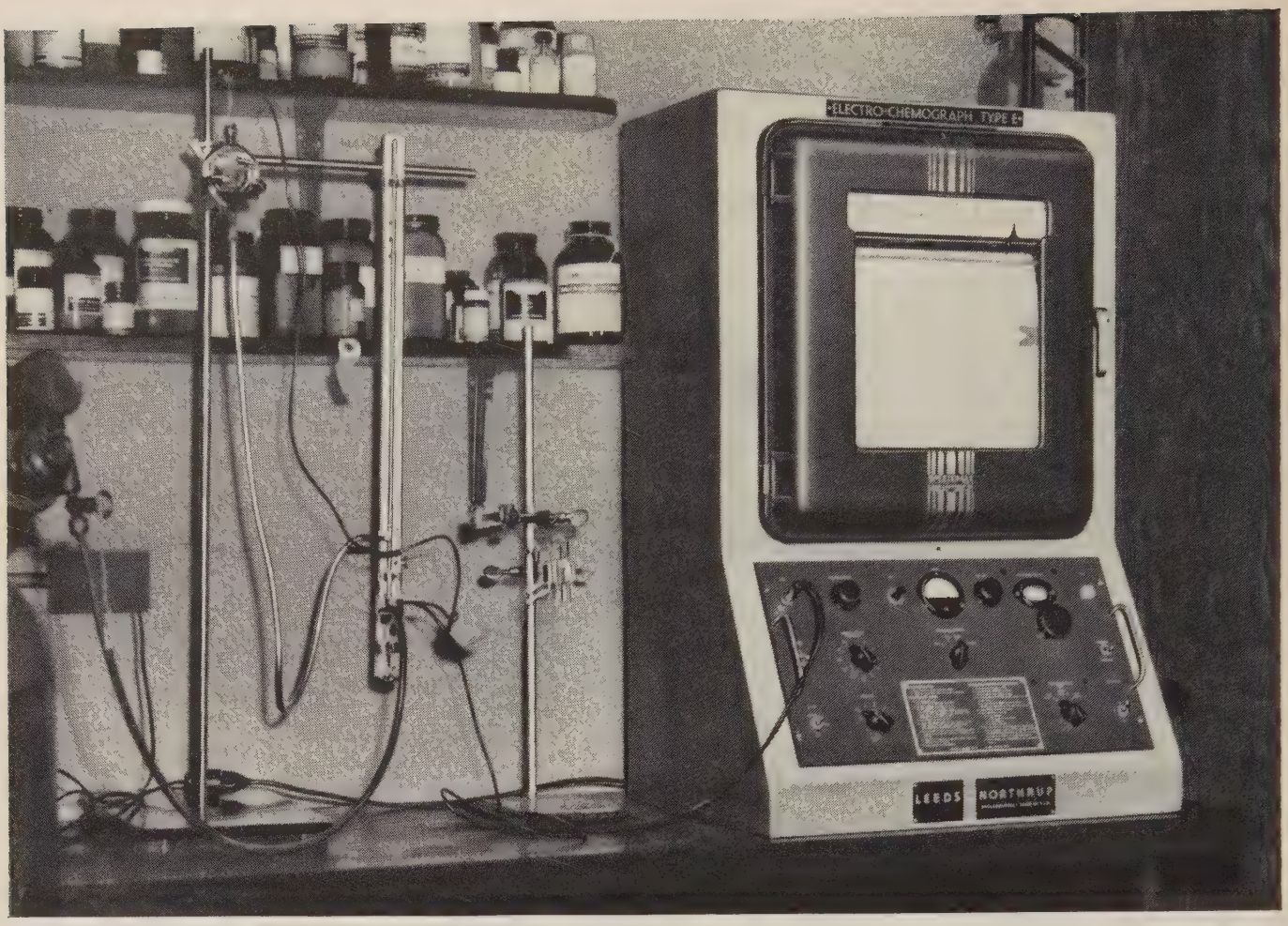

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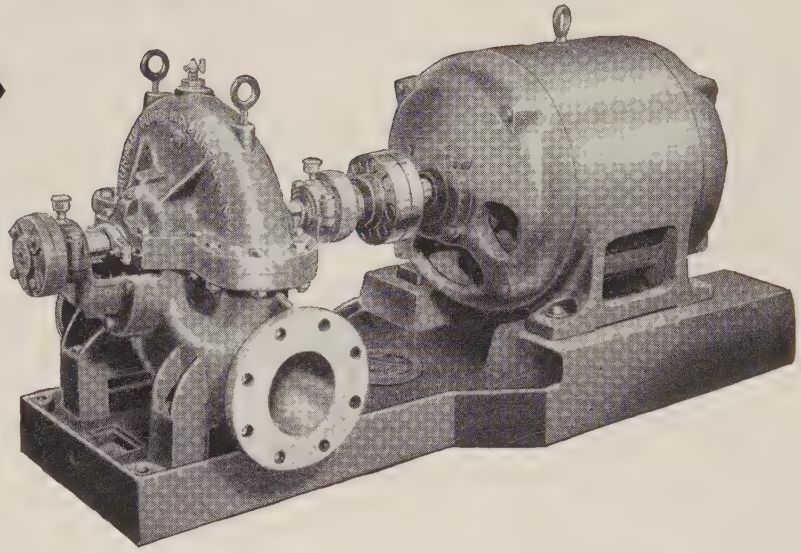

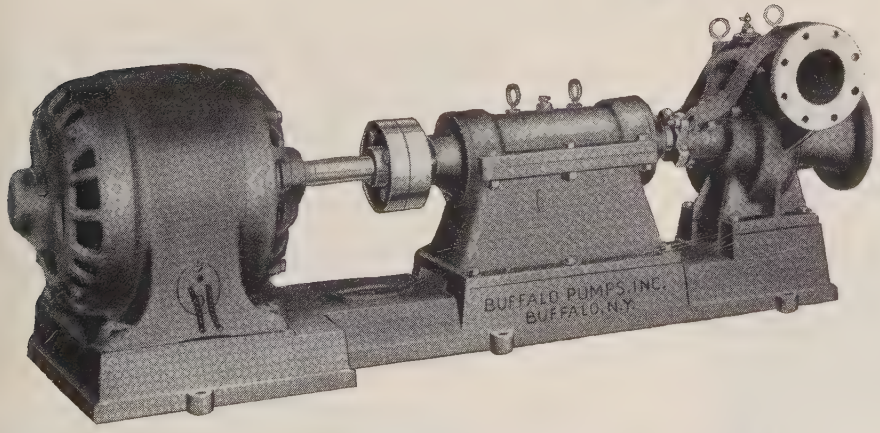

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A revolutionary development in the Wood Industries

The Bartrev Press, first automatic machine to produce board in continuous strip. By using shavings, slabs, edgings and other unused wood to manufacture board, the Bartrev Press will meet the demand for fine quality board at the low cost made possible only by continuous strip production.

THE perfection of the *Bartrev Press* after 14 years development means that a new industry has been born; for the *Bartrev Press* turns unutilized wood that has hitherto been little more than an encumbrance to the forest products industries into a vast store of treasure. Here is the crucial point: *it makes possible for the first time the continuous production of board at low cost and of uniform quality.* Bartrev board comes off the Press at high speeds in a four-foot-wide continuous strip that can be cut to measure during production.

New Ways With Wood. Success today is judged not by the trees felled but by efficiency of their use. Until now, despite every effort, more than 60% of every tree felled has to be discarded or used uneconomically. The *Bartrev Press* makes such good use of this unutilized material that the cost of board will drop.

Over 8 Miles of Board a Day. A single *Bartrev Press* can produce a continuous strip of board 4 feet wide at speeds up to 30 feet a minute — enough to make a 4-foot-wide boardwalk over 8 miles long every 24 hours . . . *over 16,000 tons of board a year!* The *Bartrev Press* means as much to forest products industries as did the continuous assembly line to automobiles and the continuous strip mill to modern steel.

The *Bartrev Press* turns wood and wood waste into a continuous sheet of fine quality board at high speeds. This is automatically cut to required lengths during manufacture.

Some Characteristics of Bartrev Board: *Length:* limited only by physical considerations in handling and transportation • *Width:* up to 4 feet • *Thickness:* from 3/16" to 3/4" • *Flexural Strength:* 2,500 to 5,000 p.s.i. according to raw material and type of board required • *Dimensional Stability:* Bartrev Board reacts to humidity changes uniformly in all directions • worked with ordinary woodworking tools — and no knot holes • natural surfaces can be waxed, varnished or painted • finishes such as: veneers, laminates, metals applied by standard methods.

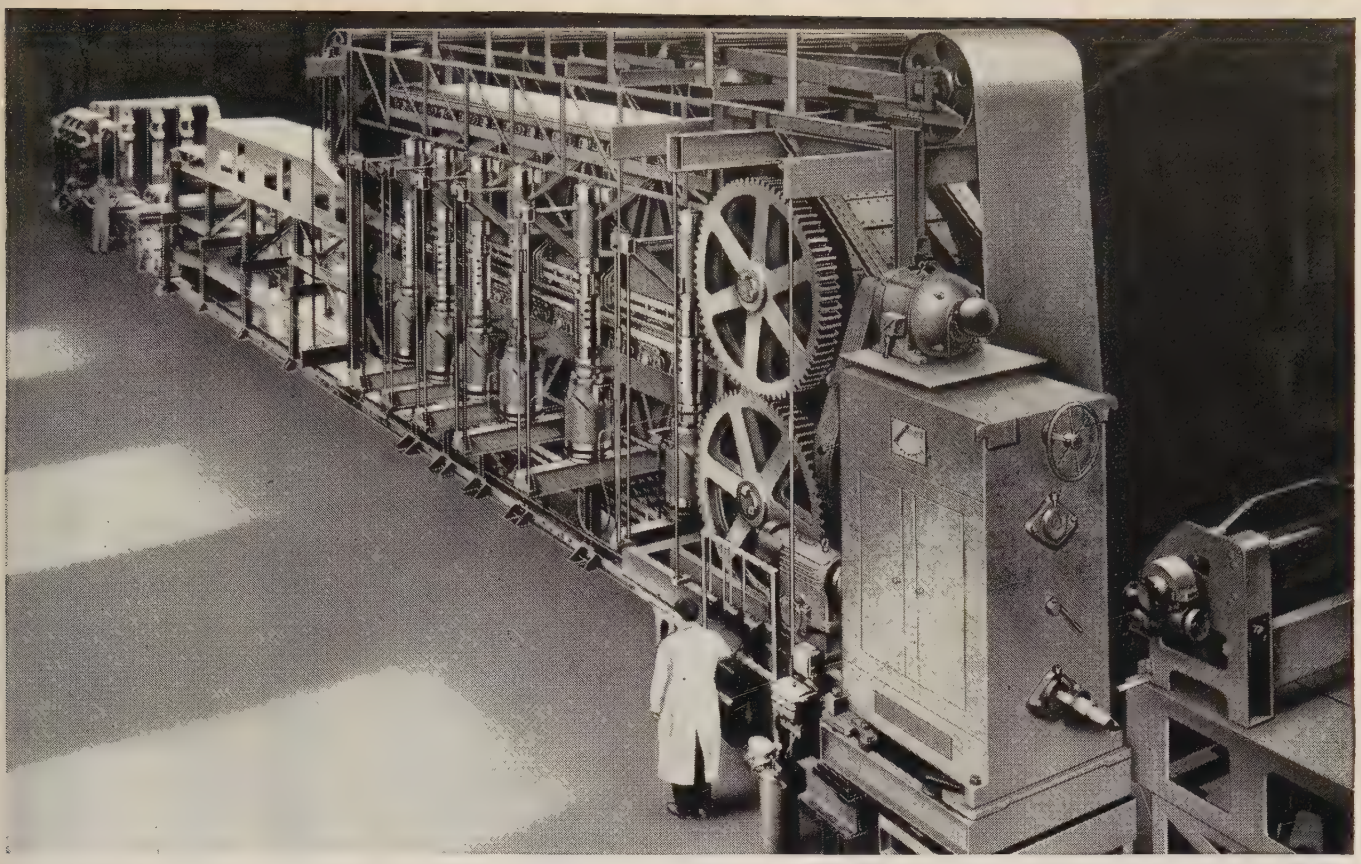
The *Bartrev Press* Opens Up Remarkable Prospects. The *Bartrev Press* is invaluable to all those engaged in the use of wood in any form. It turns waste from forest, mill and workshop into dollars. The operator of a *Bartrev Press* has no raw material problem. His raw material — unused wood — is always accumulating. Every ton of such raw material used by the *Bartrev Press* means an increase in the percentage of wood being turned to profitable account.

Some Uses of Bartrev Board: Prefabricated units for houses, offices and other buildings • for linings of buildings of all kinds • provides low cost material for ceilings, floors, flush doors, movie and theatre sets, display stands, temporary structures of all kinds • furniture and built-in furniture • low cost core for plastic laminates with many uses in stores, hotels, restaurants, built-in fixtures, all working surfaces.

First *Bartrev Press* Now In Operation. A full-scale commercial Bartrev plant is in operation near London, England. It can be inspected by arrangement. *Orders for the Bartrev Press* can now be accepted and delivery arranged from December, 1953. The installation of each *Bartrev Press* will be supervised by factory trained specialists.

ARIES FIBERBOARD CORPORATION, North American Representatives for BARTREV, LTD., 400 Madison Ave., New York City 17, N. Y. Telephone: PLaza 5-7938.

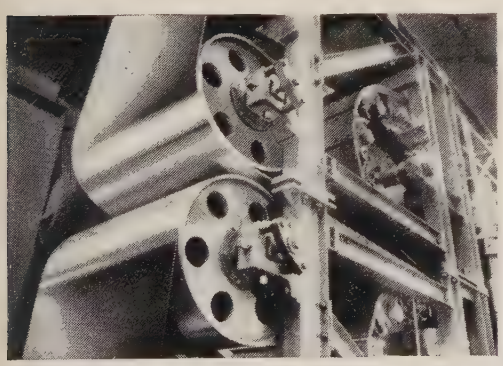
*Patents: The Bartrev Process and automatic Press have been covered by Patents and Patent Applications throughout the world.



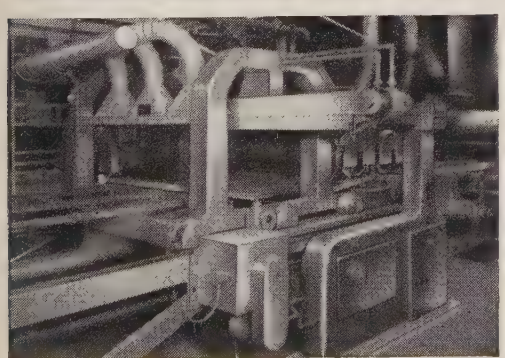
The machine that marks a new era for the Wood Using Industries

Unused wood from forest, mill and factory is mechanically reduced. After the addition of a small percentage of resin the material is fed to the *Bartrev Press* from which it emerges continuously as board that can be cut to any length. Facings of paper can be applied continuously during manufacture. The total production area required for the Bartrev plant is only 12,000 square feet.

FINISHES AND FACINGS—Bartrev board makes an excellent basis for all modern finishes. **NATURAL:** Bartrev board has an attractive natural surface texture, and can be painted, waxed, varnished or lacquered. **PAPER SURFACE:** Bartrev board can be faced with paper during manufacture. It is then ready for use. When faced with plain paper it can be given the whole range of brush and spray painting. **WOOD VENEER:** Ordinary wood veneer can be applied to Bartrev board by standard methods, using either hot or cold glues. **PLASTIC FACED:** There is no finer core material than Bartrev Board for plastic laminates in demand for bars, restaurants and store fittings. Builders, architects and interior decorators will be quick to appreciate its advantages of dimensional stability and lower cost. **METAL FACED:** Bartrev board can be faced with aluminum or other sheet metals.



The stainless steel bands of the Bartrev Press give the board a smooth and uniform surface.



The Automatic Saw receives the emerging board. The parallel saws run continuously and trim the edges, the travelling transverse saw cuts the board to any required length.

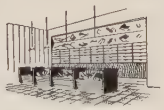
Some Applications of Bartrev Board

Prefabricated Dwellings

Trucks

Trailers

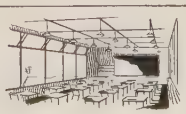
Hotel and Bar Fittings



Modern Store Fitments

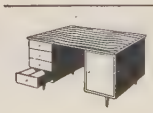
Institutional Equipment

Halls and Lounges



School Furniture

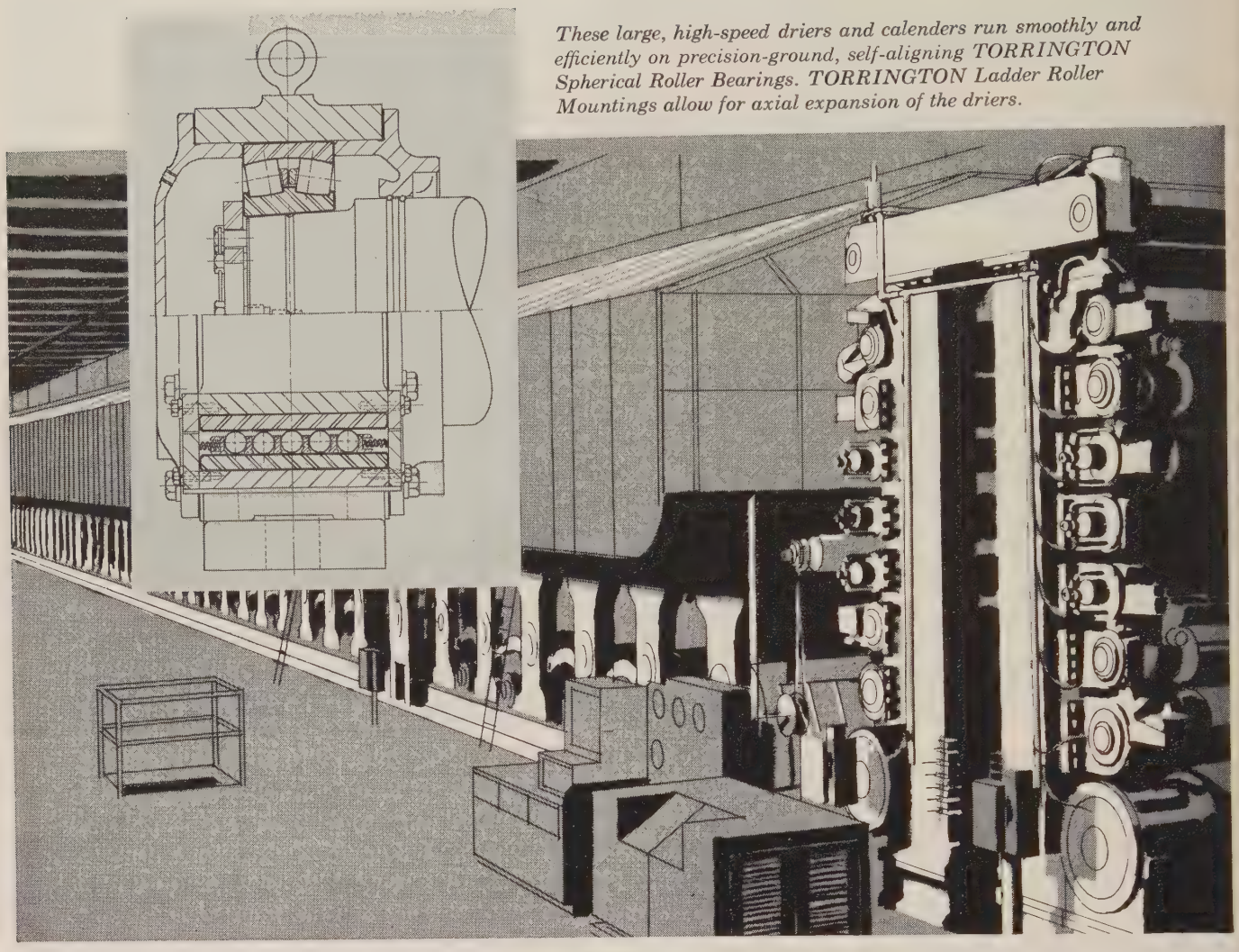
Offices and Showrooms



Office Furniture

Space-saving Furniture

Cabinets



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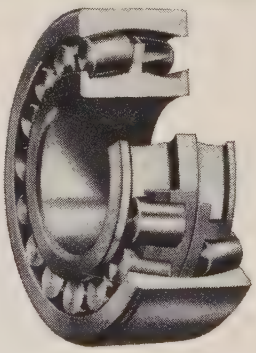

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Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

New Developments in Recovery Furnace Design

W. J. DARMSTADT

Advances in the design of recovery furnaces by The Babcock and Wilcox Co. have been directed toward lower maintenance, higher efficiency, increased availability, and ease of operation. Steam shatter jets are now arranged in the smelt spout hoods to reduce explosive violence and dissolving tank noise to an acceptable level. Close surveillance of air flow by the operator is reduced by the application of automatic air flow controllers. Additional water-cooled surface is incorporated into the furnace floor design to reduce maintenance and provide a positive seal against smelt leakage. The boiler surfaces are designed around the soot blowers. Where economically sound, all retractable type blowers are recommended. Although the cyclone contact evaporator is not universally accepted, the simplicity of design and operation plus low maintenance have proved thoroughly acceptable in those mills where it has been used. The increased thermal efficiency, low initial cost, and high availability are the principal advantages of the Pease Anthony venturi fume scrubber. Pilot scale operation of recirculating flue gas to the char bed through primary air ports indicates a practical means of reducing and controlling furnace temperatures.

THE Babcock & Wilcox Co. has been engaged in manufacturing recovery equipment for the pulp industry since 1934. In order to better serve the industry it is continually developing improvements to be applied to the equipment for the alkaline recovery process. Efforts have been directed toward lower maintenance, higher efficiency, higher availability, and ease of operation.

Since the subjects to be discussed are connected only insofar as they are an integral part of a recovery unit and not directly related, for purposes of clarity, description of the developments by the writer's company will proceed in the direction of the gas flow through a chemical recovery unit.

SMELT SPOUT SHATTER SPRAY

To lower the smelt dissolving tank noise level all new units supplied by B&W are being provided with fish-tail steam shatter nozzles in addition to the conventional green liquor circulating sprays. While the use of steam for this purpose is not new, it has been discovered that steam jets directed downward from above and tangentially to the smelt stream are more effective than jets arranged horizontally below the smelt spouts. The jets are being arranged accordingly on all new units. With these vertical jets even the noisiest smelt tanks have been quieted to an acceptable point. In addition to added safety, the increased operator comfort aids materially in maintaining good recovery unit operation.

AIR CONTROL

Due to the varying resistance as a result of smelt deposits building up in the air ports, the operators of earlier recovery units were required to make frequent adjustments of the air control dampers. These adjustments had to be correlated with the rodding of the air ports as the air flow would fall off as the ports smelted over, and increase again as the ports were cleaned.

In order to relieve the operator of this duty, an air control system has been devised which is now standard on all B&W recovery units. This system minimizes the adverse effect of inadequate rodding of ports and results in better air distribution than can possibly be achieved by manual adjustment based upon operator's judgment.

The air control system consists of two automatic control devices. First, a "constant volume" total air flow controller which automatically readjusts the setting of the forced draft damper to maintain the total air flow at a quantity which has been selected and set corresponding to the liquor firing rate. Second, an air ratio controller which meters that portion of the total air which is delivered to the primary air ports and balances this flow against the total air flow—readjusting the primary air damper to maintain a predetermined ratio between primary and secondary air flows.

The use of this control system stabilizes furnace conditions making these conditions less dependent upon close surveillance by the operator and less subject to the factors of human judgment and human error, thus making it possible to operate at optimum excess air without sacrifice to furnace stability.

FURNACE FLOOR CONSTRUCTION

Although the water-cooled refractory floor has established an excellent record for maintenance and availability, it has been found that the construction adjacent to side walls could be improved.

An additional floor tube has now been located between the furnace floor and side wall tubes. Cast steel Bailey blocks are now arranged between the side wall tubes to provide a positive barrier at the level of the floor. Flat stud plates, similar to the construction used in the upper furnace walls, are welded to the floor tubes at the horizontal center line. These stud plates are in addition to the pin-type studs which are standard construction in the hearth zone. The above-described construction is then backed up by a steel chill plate. In effect the completely water-cooled floor construction provides the most positive means of eliminating smelt leaks and reducing floor maintenance.

Better refractory materials for furnace application are being tested. Although one material shows promise, it is too early to make a specific recommendation.

SOOT BLOWING

Probably no phase of the chemical recovery process has received more attention than the problem of clean-

W. J. DARMSTADT, Process Equipment Sales, The Babcock & Wilcox Co., New York, N. Y.

ing the heat recovery surfaces. In our design special consideration has been give to the application of mechanical soot blowers.

Using all-retractable type steam blowers throughout the entire unit is gaining favor with many operators. Generally the initial investment for the all-retractable type system is lower than the combination of retractable with steam and the air-puff blower system including the air compressor and its auxiliaries. In evaluating the all-retractable blower against the combination, the frequent remark is made that "retractable blowers cost four times that of the rotating multijet element." On face value this is true, however, the superior effectiveness of the retractable blowers makes it possible to substitute one retractable for at least two positions of the fixed type units. The all-retractable soot blower system completes its blowing cycle in between one half and one third the blowing time required for the other system. The air-puff blowing cycle, however, is limited to the capacity of the air compressor. It would be necessary to at least double the initial investment of air compressor on the air-puff system to equal the elapsed blowing cycle time of the steam blowing all-retractable type installation. It can be seen that excess time is available with the all-retractable system if extra blows are necessary. Since steam is the cleaning medium, the source is always available and adequate as long as the recovery unit is in operation. As to location of blowers, suffice to say the tube surfaces have been designed around the soot blower system. An added advantage is the simplification of the maintenance program where only one type of unit is installed.

Operating experience has indicated that while operating at rated capacity, no routine hand lancing is required. As a matter of interest, it can be reported that one unit which has been in service for a period of 3 years at slightly below rating, has not been lanced to date. This fact is not reported as superior performance, but rather to indicate that more conservative selection of unit size does eliminate the laborious hand lancing which is necessary at overload operation.

HOPPER DISPOSAL

To provide an efficient means of returning the hopper dust to the recovery cycle, the modern B&W units are designed for sluicing the ash with concentrated black liquor. Several methods of doing this are used depending upon the specific liquor cycle of the mill. All methods avoid dilution with weak liquor or water, thus avoiding any adverse effect on thermal efficiency.

AIR HEATER

The interest in and need for maximum thermal efficiency in what were once primarily chemical recovery units have made mandatory continuing effort to utilize the gas air heater with optimum effect. The present trend is toward increasing concentration in multiple effects with the result that less concentration remains to be done in the direct contact evaporator after the recovery unit. At the same time increasing steam pressures and temperatures and the desire for lower exit gas temperatures provide more heat for direct contact evaporation. Since it is uneconomical or even in some cases impossible to utilize any great part of this heat in boiler or economizer surface, the gas air heater assumes increasing importance. The cleaning and maintenance problems of the gas air heater, as they are supplied today, are greatly outweighed by the thermal advantages resulting from its use. Significant advances in overcoming the cleaning and maintenance problems have been made by the use of better soot blowing equipment and better design. For soot blowing a modified standard retractable blower is used, arranged for non-rotating insertion from the side of the unit over the air heater tube sheet and having a T-head made with two orifices over each row of air heater tubes. Using superheated steam as a blowing medium, this blower has proved extremely effective in removing dust deposits in the tubes. Even more important than this is the design of the air heater for parallel flow of flue gas and air and a minimum tube metal temperature well above the dew point. That is, the gas and air both enter the heater at the top, the gas moving in one pass through the vertical tubes and the air in one or more passes horizontally over the tubes. By careful consideration of the gas and air temperatures and by proper arrangement of the tubes the coldest metal temperature, located at the bottom front of the first air pass, is maintained above 250°F. This precludes moisture accumulation and hence virtually assures ease of cleaning and prevention of corrosion.

As a further advance, closely paralleling the trend in utility boilers where gas air heaters are universal, several recovery units have been built and are building, utilizing a small one or two-section, supplemental steam coil heater in the air duct ahead of the gas air heater. This arrangement, while in no way reducing the normal thermal advantage of the gas air heater, does provide for those periods of start-up or extreme low load when metal temperatures below the desirable limit might otherwise be encountered. An attractive possibility with this arrangement is that of automatic temperature control so that both the final preheated air temperature and the gas temperature entering the contact evaporator are maintained relatively constant over a wide load and condition range. The beneficial effect on over-all ease of operation, of constant air temperature and constant liquor concentration certainly is well known by all who operate recovery units.

CYCLONE EVAPORATOR

The cyclone evaporator is finding increasing favor among operating personnel because of its simplicity and low maintenance requirements. These desirable results are derived primarily from three distinct features: first, the absence of moving parts within the evaporator, gives the operator less to worry about and reduces the maintenance problem. Second, the construction with an integral sump eliminates the need for a dump tank and greatly simplifies start-ups and shutdowns. And third, the fact that all of the liquor in the evaporator system is kept constantly moving at a high velocity minimizes the precipitation of sludge in the sump and completely eliminates the requirement of hand removal of this material, however, infrequent outages on the unit may be.

Although the use of the cyclone is not universal at present, it has proved thoroughly acceptable in those mills where it has been used. Its development is continuing and as it is improved and its advantages

become more significant, it is certain to be more widely used.

PEASE-ANTHONY VENTURI SCRUBBER

The Pease-Anthony venturi scrubber is a fume scrubber for flue gas from a recovery unit. The scrubber was developed by Pease-Anthony Equipment Co. and applied to the kraft recovery process by that company in cooperation with Thilmany Pulp and Paper Co. and The Babcock & Wilcox Co.

The scrubber consists principally of a venturi nozzle equipped with water or liquor sprays. The liquor or circulating water is injected into and atomized by the gas stream passing through the venturi. Down stream of the venturi, the liquor and flue gases are separated in a wet cyclone separator.

Based upon the pilot studies, it was indicated that additional advantages might be realized by scrubbing with strong liquor, in this way further concentrating the liquor in addition to scrubbing the gases. Two trial units equipped with such evaporative Pease-Anthony scrubbers have been purchased and will shortly be placed in operation.

These units are designed to evaporate liquor to the firing concentration, at the same time reducing the fume and gaseous sulphur losses to an economical and acceptable level. The gas temperature leaving the unit to the stack is approximately 170°F. If the commercial operation of these venturi installations confirms the original pilot studies, an increase of 6% in over-all thermal efficiency will be available as a result of the lower gas temperature.

The greatest advantages are low initial cost, trouble-free operation, and high availability. Development work is proceeding to maintain the collective efficiency at reduced draft loss.

FLUE GAS RECIRCULATION TO PRIMARY AIR PORTS

This development is in its early stages, having been proved only in pilot scale operations. The objective is to provide a quick, easy, and possibly automatic means of regulating the temperature of the incandescent surface of the char bed. Such a means would permit reasonable adjustments to compensate for mill variables such as concentration of black liquor or quantity of salt cake added to the furnace.

The desirability of a low char bed temperature is recognized so long as the furnace may be kept stable with the low bed temperature and eliminate the possibility of blackouts. The lower bed temperature could result in a decided decrease in the sublimation of sodium salts from the bed.

The introduction of a small quantity of recirculated flue gas at the same location as the primary air, possibly mixed with it, serves first as a diluent at the surface of the char bed and, secondly, as an endothermic combustion reactant to further reduce the temperature at this point. The recirculated carbon dioxide and water vapor which are reduced or dissociated by the incandescent carbon of the char bed are subsequently reformed or reburned by the secondary air so that no net heat value is lost to the boiler unit.

Tests on a pilot recovery unit with recirculation of 10 to 15% of the flue gas resulted in a change in color of the bed as seen through the primary air ports from cherry red to orange with no loss in stability. The temperature change by optical pyrometer showed a drop in bed temperature of 100 to 150°F. and an increase in temperature in the secondary air combustion zone of 50°F.

Since the degree of the effect on char bed temperature is dependent upon the quantity of gas recirculated and the quantity of gas may be changed instantly and easily, it can be appreciated that we have here an easy means of controlling bed temperatures at any stable level desired. Tests on a full-scale commercial unit are planned very soon.

Received Dec. 28, 1953. Presented at the Sixth Alkaline Pulping Conference of the Technical Association of the Pulp and Paper Industry, Mobile, Ala., Nov. 12–14, 1952.

Can the Oxygen Demand in Sulphite Waste Liquor Effluent Be Measured by Permanganate Consumption?

ERWIN SCHMIDT

It was ascertained that oxygen demand in streams does not agree with permanganate consumption in the presence of spent sulphite liquor. It was pointed out that this is due to the type of composition of spent sulphite liquor and to the entirely different reaction mechanisms of these substances with $KMnO_4$ and in biological degradation. The use of $KMnO_4$ consumption for the determination of organic substances in waste water from sulphite pulp mills and for the calculation of oxygen consumption or the "sewage load" due to spent sulphite liquor in a water course must, on the basis set forth, be rejected.

When a measure for the oxygen demand to assess the possible damage due to the introduction of sulphite waste liquor into a water course is sought, many chemists and sewage experts have a tendency to use the potassium permanganate number since this test is relatively simple to carry out. Unfortunately, it is overlooked, as was already pointed out by Haupt and others in earlier years, that the potassium permanganate number is entirely unsuitable if it is desired to determine the amount of organic material in a mixture which will demand oxygen in a stream. It must be made clear here that a permanganate determination is performed under conditions which differ fundamentally from bio-

Erwin Schmidt, Manager, Zellstofffabrik Waldhof, Wiesbaden, Germany.

logical decomposition in a stream; in the latter the conditions are great dilution, neutral reaction, low temperature, and small amounts of oxygen, while in a permanganate titration one is working with an excess of oxidant, boiling temperature, and high acidity (pH about 1.0 to 1.5). But the worst is that the permanganate consumption for various organic substances is entirely different, as shown in Table I.

The following quantities (in grams) of $KMnO_4$ are consumed per gram of organic substances:

Table I. $KMnO_4$ Consumption of Some Organic Substances

1 gram phenol	consumes	9.7 grams $KMnO_4$
1 gram tannic acid	consumes	3.5 grams $KMnO_4$
1 gram sulphite waste liquor	consumes	about 3.0 grams $KMnO_4$
1 gram lactic acid	consumes	1.0 gram $KMuO_4$
1 gram humic acid	consumes	0.8 gram $KMnO_4$
1 gram animal glue	consumes	0.1–0.2 gram $KMnO_4$
1 gram urea	consumes	0.006 gram $KMnO_4$
1 gram acetic acid	consumes	0.005 gram $KMnO_4$

Taking the first and last members of this table, the ratio of consumptions is 1935:1 or approximately 2000:1. Thus, it can clearly be seen that from a certain permanganate consumption of an unknown or of a mixture of organic substances *their amounts cannot* be calculated since the possible error can be 1:2000. An estimate based thereon rests on an obviously unsound foundation.

In spite of this known fact, there are still water laboratories which work with permanganate numbers and even try to draw comparisons on the basis of permanganate consumption with other organic sewages, for example, domestic sewage. Attempts are even made to use permanganate consumption for calculating the "sewage load of a stream" or the "population equivalent," and from there it is only a small step on the basis of such "equivalents" to calculate fees for water use or dues for sewage associations.

In recognition of the special difficulties with sulphite waste liquor, a commission was formed in Germany during the last war under the Ministry of Economics for "determination of the injuriousness of sulphite waste liquor." This commission, of which the author was a member, was able, because of the events of the war to do only some preliminary work, but the commission was unanimous that oxygen consumption in streams can properly be determined only by "biochemical oxygen demand in 5 days" (5-day B.O.D.). To be sure, the determination of B.O.D. is not simple and requires careful manipulations by trained workers if truly reproducible results are to be obtained. For dilution of the sulphite waste liquor a "consumption free" water is required and this is conveniently taken from the water course into which the sulphite waste liquor is dumped, and accordingly contains those bacteria which bring about the breakdown of organic substances in the stream. Such a stream water must then be made "consumption free" by aeration for about 20 to 30 days; that is, it must contain no organic matter which can be decomposed by the bacteria within 5 days, so that the oxygen consumption is caused solely by the added effluent and a useful measure of its action on the stream is given. It is obvious that an exactly constant temperature thermostat must be used, since the 5-day B.O.D. is a time reaction. In contrast to domestic sewage, bacterial nutrient salts must be added since spent sulphite liquor contains none or too little of these when unfermented liquors or those not subjected to the action of yeast are concerned. These short hints show that the determination of B.O.D. is not simple with spent sulphite liquor. It presupposes a certain amount of experience in biological reactions, as for example, influence of pH or influence of the phosphate reaction on the speed of the biological reaction. Only if all these factors are properly controlled will reproducible B.O.D. values be obtained.

Table II. Spruce Waste Liquor

Determined or calculated	*Waste liquor*	*Fermented (alcoholic) liquor*	*Yeast effluent*
Dry substance, %	10.18	8.30	6.76
Ash, %	1.88	1.76	1.28
Sugar, g./l.	22.8	7.0	1.2
Five-day B.O.D., mg./l.	33,450	16,900	2,500
$KMnO_4$, mg./l.	273,500	239,000	235,000
Grams B.O.D./100 g. organic matter	40.3	25.9	4.5
Grams $KMnO_4$/100 g. organic matter	329	365	427

A number of samples of spruce and beech waste liquors were analyzed for B.O.D. and for permanganate consumption. Similar samples were analyzed after their sugar content had been reduced by alcoholic fermentation and by yeast growth. Since the dry weight of the liquor is altered by this treatment, the data have been calculated to 100 grams organic substance, as shown in Tables II and III.

Table III. Beech Waste Liquor

Determine or calculated	*Waste liquor*	*Yeast treated liquor*	*Yeast treated effluent*
Dry substance, %	13.50	10.73	12.14
Ash, %	2.51	2.94	3.14
Sugar, g./l.	34.2	9.4	3.7
Five-day B.O.D., mg./l.	49,800	21,500	15,200
$KMnO_4$, mg./l.	370,000	284,000	307,000
Grams B.O.D./100 g. organic matter	45.2	21.9	16.9
Grams $KMnO_4$/100 g. organic matter	337	365	341

These two tables are very significant; the top five lines refer to the original liquors, whereas the last two give the corresponding values calculated to the basis of 100 grams of organic matter. In the spruce liquor approximately 83% of the hexoses were removed by alcoholic fermentation, leaving unattacked the remainder of the hexoses and the pentoses. The resulting liquor was further desugared by means of yeast until only about 8% of the original content of hexoses and pentoses remained. It is seen that hereby the 5-day B.O.D. and thus the oxygen demand in the stream, fell from 40.3 to 4.5 grams per 100 grams dry matter—a relative drop of 89%—whereby, for example, the growth of *Sphaerotilus* is entirely stopped. On the other hand, the permanganate consumption showed a very considerable increase from 329 through 365 to 427 grams per 100 grams organic matter. The reason for this increase

will be discussed later. On the basis of these data, it must be emphasized that 5-day B.O.D. and permanganate consumption do not run parallel and that permanganate consumption does not show the great decrease in biological oxygen demand brought about by removing the sugars.

Table III shows the corresponding data for beech waste liquor. The first column gives results on the original beech waste liquor, the second gives corresponding figures for the liquor after yeast growth, and the third gives those obtained after another treatment with yeast. This last waste liquor still contains only about 12% of the original sugars. Such liquors are hexose-free since they have been subjected first to alcoholic fermentation and contain only polymeric pentoses, which are broken down only slowly by the yeast. In any case, this table also shows that the 5-day B.O.D. is greatly decreased (from 45.2 to 16.9 grams or about 63%) by the removal of the sugars, while permanganate consumption remains practically constant.

If beech and spruce waste liquors act differently toward 5-day B.O.D. and $KMnO_4$ consumption, this is merely a new hint of the fact that these liquors are entirely different in their chemical make-up—both in kinds of sugars (spruce waste liquor sugars contain about 75% hexoses; the sugars of beech waste liquors, however, have only up to 15%) and, for example, in acetic acid content which with beech waste liquors is about three times greater than with spruce waste liquors. As shown in Table I, acetic acid consumes almost no permanganate, yet, as a C_2 compound, it serves as a good nutrient for bacteria, molds, and yeasts.

It is very instructive to show graphically the relationship between 5-day B.O.D. for 100 grams organic matter and sugar content (Fig. 1)

It is seen that the values for the two beech waste liquors are nearly identical and that both cut the axis at a 5-day B.O.D. value of 11; that is, the B.O.D. value of sugar-free beech waste liquor and thus of sugar-free lignosulphonic acid is 11 grams per 100 grams organic matter. If, from this value, the 5-day B.O.D. value for lignosulphonic acid-free sugar is calculated, a 5-day B.O.D. value of 120 grams per 100 grams sugar is obtained. By this means is obtained the very important information that the oxygen consumption by sugar

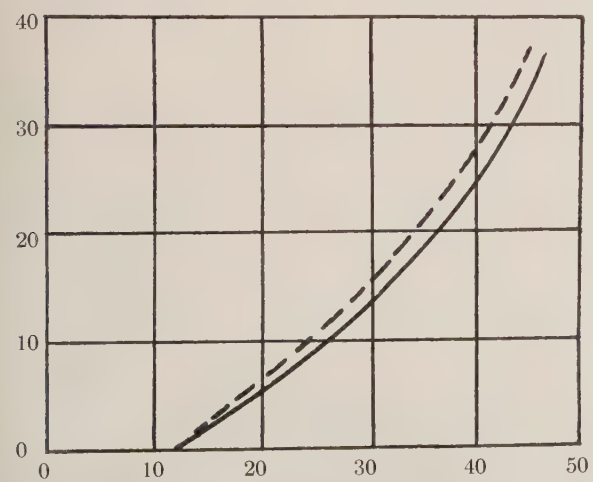

Fig. 1. Grams B.O.D.$_5$ per 100 grams organic matter in beech waste liquor vs. sugar content

is about ten times higher than that of pure lignosulphonic acid.

From this alone it is understandable why the growth of *Sphaerotilus* in streams decreases markedly with fermented (verspritet) waste liquors. But Table II shows also that yeast treatment of the fermentation residue brings about a further decrease in 5-day B.O.D. in agreement with the fact that such waste liquors treated twice biologically in general no longer cause the growth of *Sphaerotilus*, as a verdict in Switzerland in 1947 of the administration of Solothurn Canton points out concerning the waste liquor of Attisholz pulp factory. Attisholz is indeed the only factory in the world which first ferments spruce waste liquor (for alcohol) and then subjects it to the action of yeast. The verdict pointed out that by passing through both plants (fermentation and yeast factories), even with favorable time conditions for the growth of *Sphaerotilus*, where no further yeast growth occurred no growth of *Sphaerotilus* was found.

If one seeks the reason why permangenate consumption fails so dismally with sulphite spent liquors, it is undoubtedly based on the fact that spent sulphite liquors consist of the most varied organic substances, e.g., lignosulphonic acid, hexoses, pentoses, and acetic acid, which consume entirely different amounts of $KMnO_4$ that is in no way parallel to the likewise varying 5-day B.O.D. To make this better understood it would be necessary to determine the exact $KMnO_4$ and 5-day B.O.D. values of each substance present in spent sulphite liquor. We have not yet done this, but nevertheless we believe that we know their orders of magnitude and will use these values to show by calculation how by desugaring of the spent liquors and by removal of acetic acid with yeast the two consumptions (5-day B.O.D. and $KMnO_4$) must undergo entirely different changes and at times may even go in opposite directions.

For this calculation we shall assume that consumptions in 5-day B.O.D. and $KMnO_4$ per 100 grams of organic matter are as follows:

	Grams $KMnO_4$ per 100 grams organic matter	*Grams 5-day B.O.D. per 100 grams organic matter*
Lignosulphonic acid	370	11
Sugar	350	120
Acetic acid	0.5	60

Furthermore, we shall take as a basis for calculation, an unfermented spent beech liquor containing in the

Table IV. Calculated $KMnO_4$ and 5-Day B.O.D. Values as a Function of Composition of Spent Liquor

Spent sulphite liquor	*Grams $KMnO_4$ per 100 g. organic matter*	*Grams 5-day B.O.D. per 100 g. organic matter*
Original of above composition	327.8	43.2
After removal of acetic acid	364.1	41.3
After removal of 85% of the sugar	321.7	22.5
After removal of 85% of the sugar and all the acetic acid	344.5	18.5

organic matter 65% lignosulphonic acid, 25% sugar, and 10% acetic acid. We shall then calculate the following three cases, in which (1) 85% of the sugar, (2) the acetic acid only, and, finally, (3) 85% sugar and all the acetic acid have been removed, as is the case with intensive yeast action. Thus are obtained the following calculated values for 5-day B.O.D. and $KMnO_4$.

Table IV shows that the removal of 10% acetic acid in the organic matter appreciably increases the permanganate consumption since the permanganate consumption is about 700 to 750 times smaller than those of lignosulphonic acid and sugar. In contrast the 5-day B.O.D. shows a slight tendency to decrease. The removal of sugars is hardly noticeable in permanganate consumption, obviously because the permanganate consumptions of lignosulphonic acid and of sugar lie close to each other, while the 5-day B.O.D. of the two substances is in the ratio of 1:10, and therefore the removal of a little sugar reduces the B.O.D. considerably.

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The Continuous Manufacture of Semichemical Pulp for Corrugating Board

J. McK. LIMERICK

As a means toward the conservation of natural resources the Bathurst Power and Paper Co. has for some years been increasing its yield from the softwood species. This has been followed by the production of corrugating board from all available species of hardwoods by a continuous process. Thus complete utilization and over-all conservation is being practiced. A description of the mill is given. The continuous process is also described, including chipping, chip and chemical feeding, cooking, refining, washing, and board making. Pulp quality at various states of the process is given.

For many years the Bathurst Power and Paper Co. has devoted a good portion of its development efforts toward obtaining greater yield from a given quantity of wood and thus conserving the natural resources of the forests in which it operates. A concrete example of the success of its efforts is the high yield process in use in its kraft mill where kraft pulp is currently being made at a yield of 62% (*1, 2*).

During the same period much study was given to the utilization of hardwood which exists in rather large quantities in the New Brunswick area near Bathurst and which had not been used to any great extent. A commercial outlet for these little-used species would add to the tonnage of the mill and at the same time make no further demands on the softwood types.

In the course of the development work it became apparent that pulp made from hardwoods cooked by a semichemical process could be made into a corrugating board having superior rigidity. The development fitted well into the integrated Bathurst organization which by now had acquired two plants manufacturing corrugated shipping containers. Thus a new semichemical mill, using hardwoods, allowing complete utilization and therefore over-all conservation of the forest, was added to the already diversified Bathurst operations. It is known as the BCM mill, meaning, Bathurst corrugating medium.

DESCRIPTION OF THE BCM MILL

The flow diagram for the process is shown in Fig. 1. All hardwood species in the area, principally poplar, beech, maple, and birch, are used in the process. The wood is delivered to the mill in either 4 or 8-ft. lengths by truck and is stored in regular piles or added direct to the conveyor feeding the chipper. Wood can be hand-fed into the conveyor but the greater portion is fed by means of a crawler crane into a movable feeder which keeps the cable conveyor supplied with wood. The feeder is self-propelled and moves on a track beside the conveyor. One section of the conveyor, just after it enters the building, consists of a specially designed washing system which cleans the wood and removes all dirt and sand.

After the wood enters the building, which is 50 by 200 ft. (built of hollow concrete blocks made on the job), it is conveyed to the Carthage 10-knife chipper, located in one corner and on the same level as the operating floor of the plant. From the chipper the chips flow to a surge bin which feeds two Dillon triple deck vibrating screens. Oversize chips are passed through a Carthage rechipper and returned to the surge bin. Accepted chips are lifted by means of a Jeffrey bucket elevator operating at the rate of 12,000 cu. ft. per hr. and discharged into a Jeffrey spiral conveyor which distributes the chips evenly into a concrete chip silo having a capacity of 38,000 cu. ft. or sufficient for about 18 hr. operation. The silo is emptied by means of a rotary vane chip feeder which discharges the chips into a belt conveyor feeding a second bucket elevator.

The bucket elevator delivers the chips to a Dings magnetic separator (to remove tramp metal) and hence to screw conveyors which feed the two chip hoppers supplying the continuous pulping apparatus. The pulping equipment is in two units, one of which is described as follows: At the operating floor level the chips enter a variable speed screw feeder manufactured by the American Defibrator Co. and, as the plug of chips is formed, chemical in the form of a modified kraft liquor is added. At the same time steam is injected to bring the combined chips and chemical to a pressure of 150 p.s.i. Proper provision is made at this point so in the case of any stoppage in the flow from the hoppers or any other temporary difficulty within the screw feed the steam will blow back into a cyclone and not give rise to a hazard on the operating floor.

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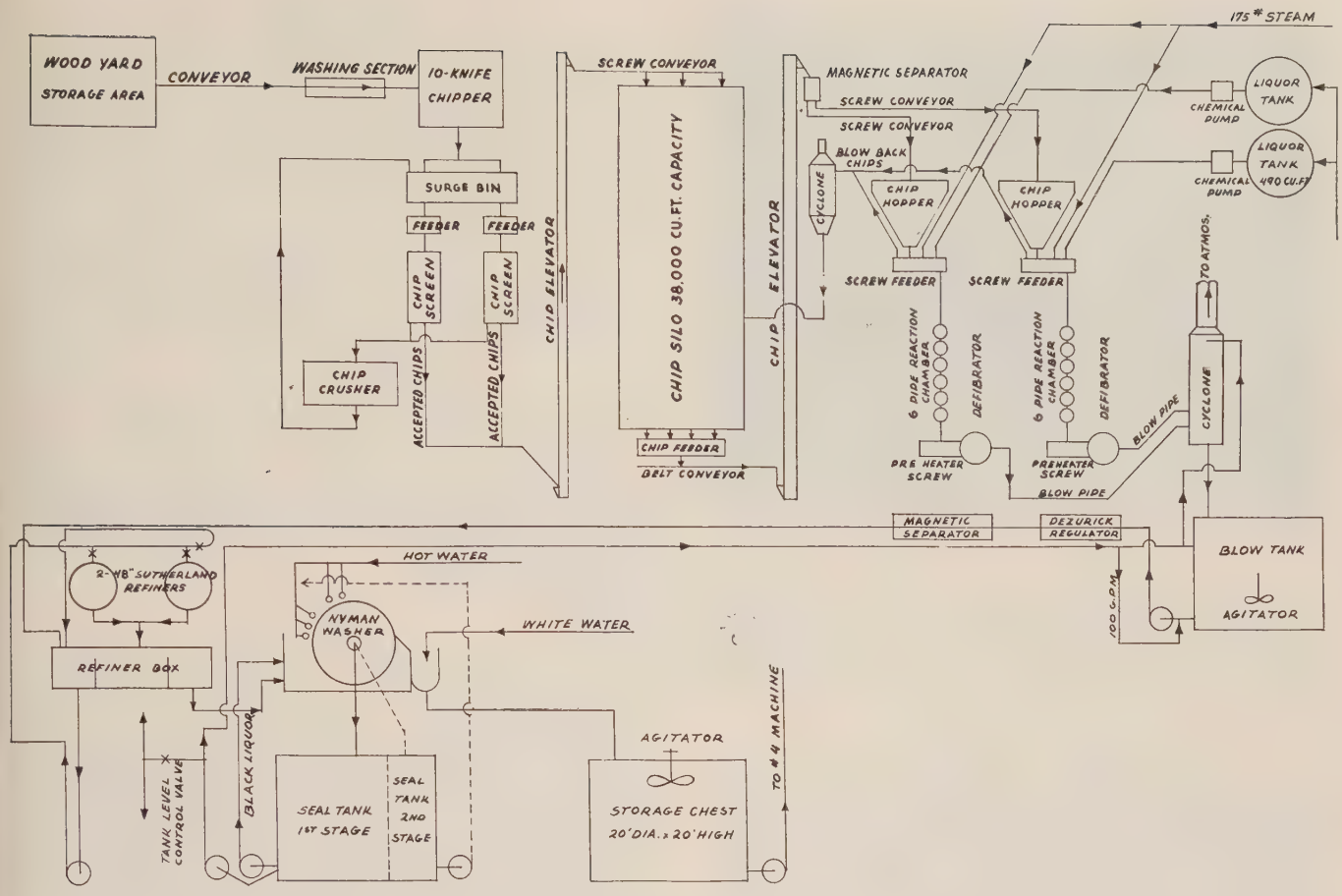


Fig. 1. Flow diagram for the Bathurst process

The mass of chips and chemical at cooking pressure drops to a six-pipe one-way flow BK reaction chamber manufactured by Pandia, Inc. Each pipe of the reaction chamber is 24 in. in diameter and 19 ft. long and is stainless steel clad. Provision is made for the addition of two other pipes should they be required in future. Within each pipe is a worm conveyor driven by a Reliance drive and synchronized with all six pipes so that the reaction time may be varied within wide limits. Thus the chips pass along each pipe and drop to the next at such a rate that the cooking time, or the time of passage through all six pipes, can be closely controlled and changed when necessary.

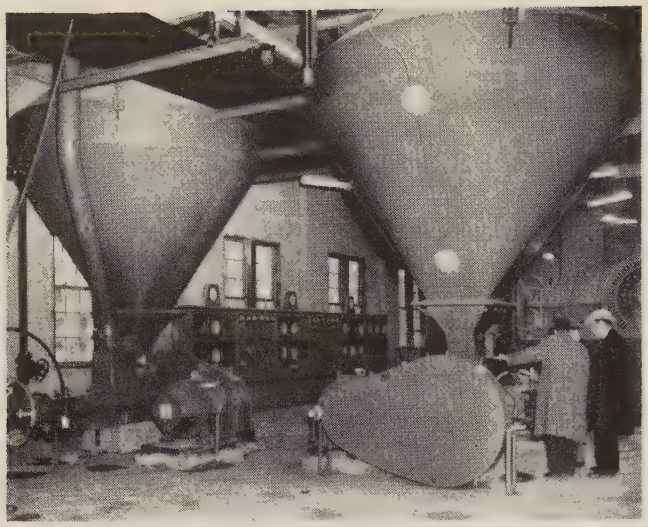
The chips in this process are cooked semichemically so that they must be defibered mechanically at the end of the pulping operations. At the end of the reaction time in this continuous system the softened chips, still under cooking temperature and pressure, are fed to an Asplund defibrator, manufactured by the American Defibrator Co. This is a rotary disk-type refiner which operates under cooking pressure and defibrizes the hot chips into pulp. From the defibrator the pulp is blown to a cyclone from which the steam escapes and the stock, diluted with black liquor, passes to an agitated tile-lined blow chest where it is at a consistency of 6%. As previously mentioned, there are two identical pulping units discharging into the blow chest, located at ground level.

From the blow tank the pulp is pumped through a De Zurik pressure consistency regulator, a second Dings magnetic separator, and arrives again at the operating floor level. Here the stock is passed through two Sutherland refiners arranged in parallel and having 48-in. disks driven by 350-hp. motors. The refining action at this point is the same as the brown stock refining process originally developed by Bathurst in their kraft mill (*1*). After the refiners the pulp is washed on a two-stage 9 by 16-ft. Swenson-Nyman washer and it then drops to a Semtile storage tank of 6000 cu. ft. capacity, manufactured by Stebbins Engineering. At this point the stock is ready to be pumped to the board machine.

All the important operations in the plant, such as chip and chemical feed, refining, and pulp washing are located on the operating floor so that the operators may have easy access to them. In addition, the entire plant is under push-button control from the same floor. The operating panel with recorders and controls was manufactured by the Foxboro Co. and supplied by Peacock Brothers of Montreal. The controls and layout of the plant are such that the entire operation is carried out by two men per shift plus the chipper man on one shift only.

The BCM plant, which is the first mill in Canada manufacturing pulp for corrugating board by a continuous process, was designed and erected by the engineering and construction staffs of the Bathurst Power and Paper Co. The mill was built for a production of up to 200 tons per day but the present requirements of the paper machines do not permit of tonnages as high as that figure. Since the start of operations in January pulp yields have been about 75%.

The hardwood semichemical pulp as made in the described fashion is pumped to the paper machine room where it is mixed with just sufficient regular kraft pulp to impart some tensile strength to the sheet. The



Operating floor and instrument panel

stock passes through one jordan and then to two 48-in. Sutherland refiners arranged in parallel. After refining the pulp is run into corrugating board on a fourdrinier machine trimming 146 in.

PULP QUALITY

In the manufacture of corrugating board rigidity as measured by the flat crush test on the combined board is the important quality for most uses. Over several years, studies have been made in an effort to develop a test on the 9-point sheet which would predict its rigidity in the finished container. This is especially important when the container plants are in a different location from that of the paper mill. Until recently none of the tests used were satisfactory and several were definitely misleading. However an instrument has been developed at The Institute of Paper Chemistry, known as the single flute corrugator, which has made available a test which checks very well with the regular flat crush test made on the combined board. The single flute flat crush has been used extensively at Bathurst for research and development purposes and is now employed as the important control test.

It might be of interest to see how the flat crush develops throughout the process. The following shows a typical series of tests on 26-lb. handsheets made from pulp taken at various points. Freeness results are also included.

Sample	*Single flute flat crush, p.s.i.*	*Freeness Canadian (Standard), ml.*
After defibrator	2.7	800
After pulp mill refiners	14.2	660
After paper machine refiners	27.5	490
Paper machine headbox	33.8	275

It will be apparent that refining plays a large part in bringing out the rigidity of these hardwood pulps. In addition, as shown by the test at the machine headbox, white water fines increase the flat crush. Paper machine white water when running hardwood pulp is high in fines. The whole problem of the rigidity of hardwood pulps and the effect of various factors is currently under study by the Bathurst organization and some interesting points are being brought to light.

SUMMARY

In the development of the BCM corrugating sheet, not only have Bathurst found a use for hardwood but they have produced a board which is distinctly superior in quality to their previous product. The rigidity has been almost doubled and the running qualities on the corrugator are improved.

During 1951 a container research and development division has been set up in Montreal by Bathurst. As more studies are made in this department, as well as at the mill, further improvements are anticipated.

LITERATURE CITED

1. Limerick, J. McK., and Callaghan, C. V., *Pulp Paper Mag. Canada* 52, No. 3: 175–180 (Convention issue).
2. Limerick, J. McK., "The Properties of High Yield Kraft Pulps Produced at Bathurst." Paper presented at annual TAPPI Convention, February, 1951.

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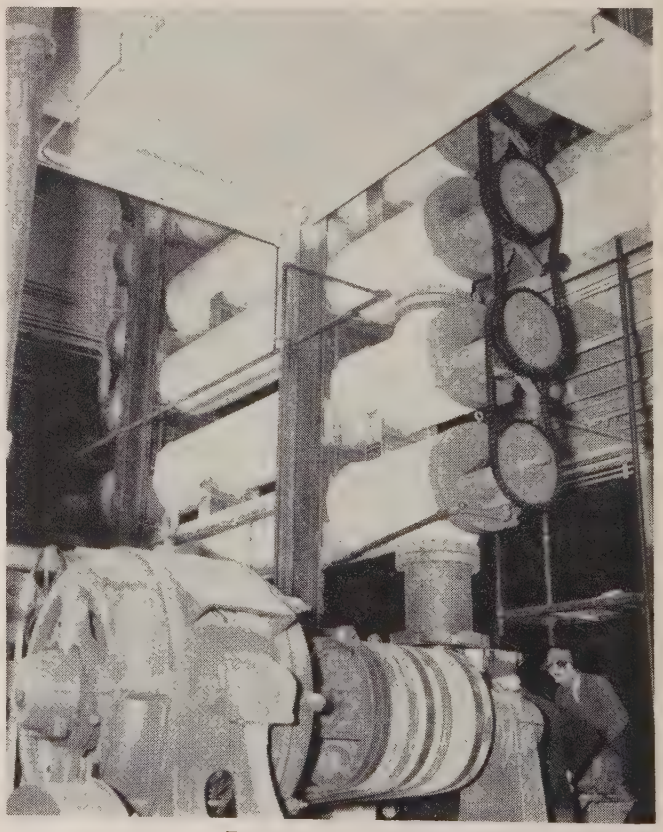
APPENDIX

Since the presentation of this paper in 1951 a major change has been made in the operation of the semi-chemical pulp mill. At the time the Bathurst Research Division had already brought out two important points: (1) that if the solids which have been dissolved from the wood are retained in the sheet under the proper conditions, the rigidity is increased, and (2) that if a pure caustic soda solution is used in place of kraft liquor as the cooking medium under the special conditions of the BCM cook, the pulp is of the same quality as the kraft-cooked hardwood.

The changes suggested above were put into commer-



Reaction chambers

cial operation during the last half of 1951 and have resulted in several improvements in the operations. Kraft liquor was completely replaced with a caustic soda solution. To take advantage of dissolved solids retention the continuous washer in the semichemical plant was by-passed and paper machine white water was returned to the semichemical pulp mill for dilution. The change resulted in an almost completely closed system and the important consequence has been a yield well in excess of 90% from the wood.

Other advantages have accompanied the change. Whereas even the washed pulp prepared with kraft liquor had an objectionable odor, the new unwashed sheet is odor-free. Certain corrosion around the plant (particularly on the instrumentation) which resulted from the use of kraft liquor has been eliminated. Improvements have also resulted in the kraft mill operations since the BCM plant has been completely separated from it. The use of kraft liquor in the semichemical operation without returning any chemical back in the way of recovery resulted in a make-up problem which led to difficulty in controlling sulphidity within reasonable limits. This problem has now been eliminated. The liquor formerly washed from the pulp was sent to the sewer thus leading to possible pollution, but the elimination of washing and closing of the system has remedied this phase of the problem.

Received Aug. 1, 1952.

Mannangalactan Gums—The Mechanism of Retention by Paper Fibers

N. S. GRUENHUT

Since about 1949 mannangalactan gums have been used extensively in the paper industry as wet end additives to permit increases in machine speed and to give added bursting strength to the finished paper. The retention of these gums and some of their borate complexes by the paper fiber is determined by a viscometric method. It is demonstrated that linear gums are retained by adsorption on the fiber surface and thus are dependent upon the gum concentration, while highly branched or cross-linked gums are retained more securely and, within certain concentration limits, independently of the gum concentration. A theory for the mechanism of retention is presented, based on hydrogen bonding.

Natural beater additives have been used in the manufacture of paper all through the ages. Gums and mucilages have been used in oriental countries such as in the manufacture of the nearly perfect handmade Japanese yoshino paper. Starches were used as early as 3500 B.C. and are still one of the major raw materials used for many grades of paper. In England, Broadbent and Harrison (*1*) tried to duplicate the Japanese procedure of mucilage extraction using the British pulp evaluation equipment to determine the general effect of mucilages on sheet formation.

In the United States The Institute of Paper Chemistry (*2*) discussed the uses of gums and mucilages in papermaking and presented data on the effect of mannangalactan gums (guar and locust bean gum) on beating time and strength properties of various pulps. Brief data were given on the retention of guar gum. The retention was investigated by Dreywood's (*3*) anthrone colorimetric carbohydrate test as described in detail by Morris (*4*) and an alternative viscometric method (*5*).

The technique of viscosity determinations to evaluate the retention of unmodified and modified mannangalactan gums on pulp was adopted in our laboratory.

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EXPERIMENTAL METHODS

Rosin sized kraft pulp was beaten in the Noble and Wood laboratory beater to a freeness of 600 to 650, pH adjusted to approximately 6.5, washed with distilled water and centrifuged in a basket centrifuge using a 30-mesh wire insert. The moisture of the centrifuged pulp was determined by drying duplicate samples to constant weight at 105°C. The consistencies used in the following experiments were made up on the moisture-free basis.

One sample of washed, centrifuged pulp was redispersed in distilled water to give a 0.5% consistency and used as a blank. Consecutive pulp samples were redispersed to give 0.5% suspensions in mannangalactan gum solutions of varying concentrations. The gum solutions were made up on a moisture-free basis, cooked for $^1/_2$ hr. on the steam bath (190–200°F.), cooled, and moisture loss made up.

The pulp suspensions in distilled water and those in gum solutions were agitated at the same speed for 10 min., then left to stand overnight. The supernatant liquids were decanted by pipet and filtered through a Corning coarse microfilter. All these operations were conducted at 72 ± 3°F. and 50 ± 2% R.H. Ten milliliters of the white waters obtained in this manner were introduced by pipet into a Cannon-Fenske viscometer series 50. The solution efflux time was measured in duplicate at 25 ± 0.1°C. after allowing 10 min. for the solution to reach temperature equilibrium.

For calibration purposes viscosities of each modified and unmodified gum were run at various concentrations in distilled water after the solutions had been treated as described above. The actual loss in concentration by the filtration process was determined and corrections made in calculating the concentrations of the gum solutions.

EXPERIMENTAL RESULTS

Table I shows some viscosity and concentration data for guar and locust bean gum solutions.

Figure 1 shows the viscosity calibration curves for these two gums where relative viscosities as taken from Table I are plotted against the corresponding concentration in grams per 100 ml.

Table II shows the relative viscosities of the white waters of 0.5% pulp suspensions in distilled water and in gum solutions of different concentrations.

From the modified form of the Arrhenius equation

$$\underset{\text{(residual gum)}}{\text{Log } \eta_r} = \underset{\text{(white water + residual gum)}}{\log \eta_r} - \underset{\text{(white water)}}{\log \eta_r}$$

the relative viscosities of the residual gum (gum not adsorbed by the paper fibers) are determined.

With the help of the calibration curves (Fig. 1) the concentrations of the residual gums, corresponding to their relative viscosities are determined. By subtracting the concentration of the gum not adsorbed from the originally available amount, the concentration of the gum taken up by the fiber is calculated.

Concentration-Retention Relationship

Table III shows original, residual, and sorbed gum concentrations on a per cent basis and pounds per ton of pulp both for locust bean gum, and guar gum.

It can be seen clearly that sorption of these two gums is dependent upon the concentration used, this concentration dependency being less pronounced in guar than in locust bean gum.

Considering Freundlich's adsorption isotherm equation:

$$\frac{x}{m} = a \cdot c^{1/n} \quad \text{or} \quad \log \frac{x}{m} = \log a + 1/n \log c$$

where

x = amount of gum sorbed
c = concentration of unadsorbed portion in solution (or equilibrium concentration)
a and n = constants, characteristic of the adsorption process under consideration
m = weight of adsorbing material ($1/n$ can be neglected as long as the weight of the adsorbing material is kept constant)

and plotting the retained or sorbed quantities of gum against the gum in solution equilibrium (residual gum) on a logarithmic scale (Fig. 2) it can be seen that the slope of guar gum differs considerably from that of locust bean gum.

Table I. Viscosity Calibration Data
Temperature: 25° ± 0.1°C.

Concentration, g./100 ml.	*Efflux time, sec.*	*Centistokes*	η_r
	Locust Bean Gum		
0.0468	653.3	1.721	1.955
0.0351	548.5	1.449	1.642
0.0234	465.5	1.230	1.394
0.0175	429.3	1.134	1.285
0.0117	395.0	1.044	1.182
0.00702	369.4	0.976	1.106
0.00468	357.5	0.944	1.070
0.00351	351.8	0.929	1.053
	Guar Gum		
0.0636	637.1	1.683	1.905
0.0458	530.5	1.402	1.586
0.0318	458.0	1.210	1.370
0.0229	420.7	1.111	1.258
0.0198	405.3	1.071	1.212
0.0159	392.2	1.036	1.173
0.0114	374.7	0.990	1.202
0.0095	367.3	0.970	1.098
0.0079	360.6	0.953	1.078
0.0059	352.5	0.931	1.054

At higher concentrations locust bean gum is adsorbed by the fibers to a much higher degree than guar. The reason for this behavior can be explained by the difference in molecular structure.

MECHANISM OF RETENTION

Swanson (*6*) and Ahmed and Whistler (*7*) reported that guar gum is branched to a higher degree than locust bean gum. Comparing the sorption of gum with that of starch it has been shown before that within the same time limit the amount of amylose sorbed at a given time was significantly higher than the amount of amylopectin sorbed. The same principle seems to apply here: the less branched locust bean gum is adsorbed more rapidly than the more branched guar gum.

Having found the sorption of gum to be a function of its concentration, it can be concluded that sorption takes place on the surface of the fiber. Since cellulose and gum molecules in solution have similar molecular structure and are both capable of hydrogen bonding within themselves and with water, the possibility of alignment between the two materials is great. The rate of collisions between the cellulose and gum molecules depends upon the concentration of the gum and the available surface area of the cellulose (the gum apparently being sorbed on the cellulose surface) and on the amount of gum already deposited there. The method of attachment in both cases is probably the same because of the similarity of those polysaccharides. In dilute solutions where the possibility of collision or the approach of interacting groups within 3A of each other in order to form a hydrogen bond is less probable, sorption will be decreased.

To demonstrate this dilution dependency a series of experiments was run where the concentration of gum on the pulp was kept constant, but the total volume in which they were reacted was varied. It was found that sorption decreased significantly with increasing dilution.

Temperature and pH Conditions

The rate of sorption will vary not only with dilution but with the temperature and the pH, being more rapid at lower temperature (4.2°C.) and at lower pH (around 4) which can be considered an indication of hydrogen bonding as water is less associated when hot than cold and because of the exothermic nature of the bonding. This is borne out by the production of handsheets at low temperatures where higher strength values were obtained than with sheets made at usual temperatures.

GUM-BORATE COMPLEXES

As pointed out previously, the use of these unmodified gums in the paper industry is not new, but papermakers encountered difficulties in dispersing these gums to achieve practical workable concentrations.

To overcome these difficulties mannangalactan gums have been blended with borax and low molecular weight polyoxy compounds.

Borates have been used to detect and estimate mannangalactan gums by Hart (*8*). By polarimetric measurements on solutions containing boric acid, borax or

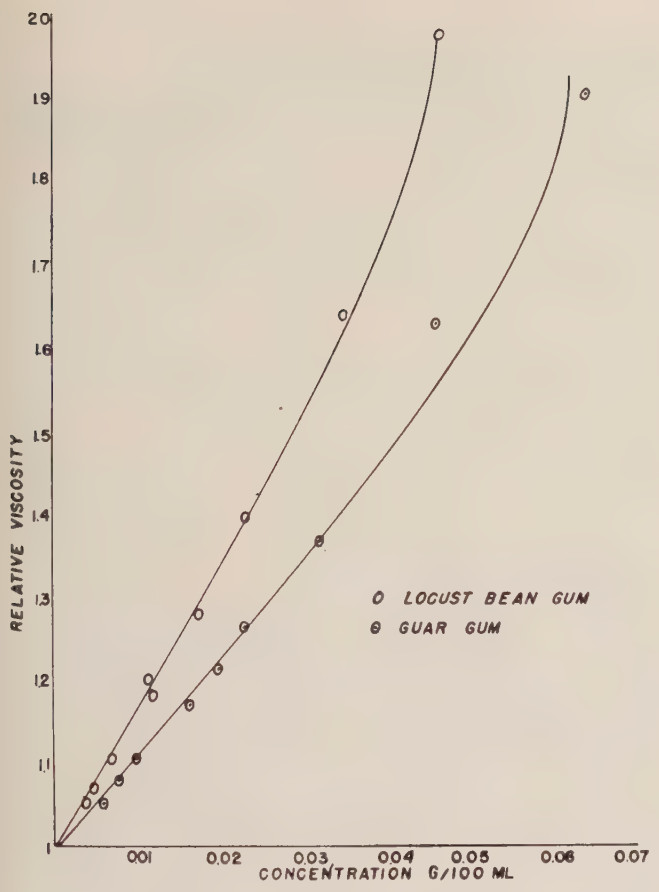


Fig. 1. Calibration curves

metaborates and mannitol, glucose, or other nonionizable short chain polyhydroxy compounds it was shown by Tuzuki (*9*) that very little tendency exists to form complexes with boric acid, but that gel formation readily increases with the concentration of metaborate ions.

Deuel and Neukom (*10*) discuss in detail the reaction of boric acid and borax with polysaccharides and other high molecular polyoxy compounds. Complexes are formed not only with low molecular weight polysaccharides, but with high molecular compounds as long as adjacent cis-hydroxyl groups are present. In aqueous solutions of these high molecular polyoxy compounds di-diol complexes are formed which lead to the formation of a three-dimensional gel network. These di-diol complexes exist in a form of dynamic equilibrium. They dissociate continuously and form again. This

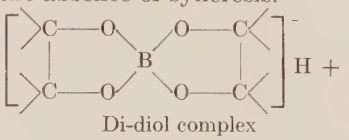
Table II. Viscosity of White Waters
Temperature: 25° ± 0.1°C.

Experiment	*Efflux time, sec.*	*Centistokes*	η_r
Blank	334.1	0.883	1.005
App. 1% locust bean gum/pulp	343.1	0.907	1.032
App. 0.5% locust bean gum/pulp	337.9	0.893	1.016
App. 0.25% locust bean gum/pulp	334.5	0.884	1.006
Blank	335.0	0.885	1.002
App. 2% guar gum/pulp	362.5	0.958	1.084
App. 1% guar gum/pulp	345.9	0.914	1.034
App. 0.5% guar gum/pulp	338.5	0.895	1.013
App. 0.25% guar gum/pulp	335.6	0.887	1.004

Table III. Sorption Data
Temperature: 72° ± 3°F.

Experiment	*Original concentration* — %	*Original concentration* — *Lb./ton pulp*	*Residual concentration* — %	*Residual concentration* — *Lb./ton pulp*	*Sorption* — %	*Sorption* — *Lb./ton pulp*
Locust bean gum	0.936	18.7	0.38	7.6	0.556	11
	0.468	9.4	0.16	3.2	0.308	6
	0.234	4.7	0.02	0.4	0.214	4
Guar gum	1.984	39.7	1.60	32	0.384	7.7
	0.996	20	0.64	13	0.356	7
	0.502	10	0.22	4.4	0.282	5.6
	0.250	5	0.04	0.8	0.210	4

ability to change the place of the net-forming center explains the lability of the system, the thread formation of the gel and the absence of syneresis.



Di-diol complex

These polysaccharide-borax gels are easily solvated by acids and form only in weakly alkaline solutions.

In the presence of low molecular polyoxy compounds (fructose, mannose, glycerin, glycol) capable of forming borate complexes themselves, the polysaccharide-borax gels are liquefied to some extent and the viscosity of the macromolecular complex can be controlled.

A mannangalactan gum-borax-low molecular polyoxy compound combination is not only easily dispersible, but has other properties superior in some ways to the unmodified gums. These properties are due to the cross-linked structure as shown in the following experimental data.

Sorption

Both locust bean gum and guar gum have been tested in formulations containing borax. Solutions were made up and treated in the same manner as the unmodified gums. Viscosity calibration curves were drawn from which the concentrations of the unadsorbed or residual gum were determined and retentions were calculated.

Table IV shows concentration and viscosity data and in Fig. 3 the corresponding calibration curves can be seen.

Table V represents concentration and sorption data on a per cent basis and in pounds per ton of pulp.

In Fig. 4 the sorbed portions of a locust bean gum-borax-glyoxal and a guar gum-borax-sugar blend are

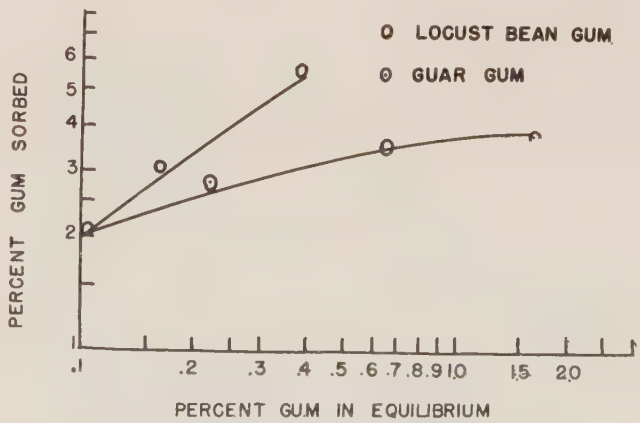


Fig. 2. Adsorption isotherms

Table IV. Gum-Borate Complex Viscosity Calibration Data

Temperature: 25° ± 0.1°C.

Concentration, g./100 ml.	*Efflux time, sec.*	*Centistokes*	η_r
85% Locust Bean Gum, 11% Borax, 4% Glyoxal			
0.060	590.1	1.559	1.775
0.040	504.3	1.332	1.517
0.030	451.1	1.192	1.357
0.020	406.2	1.073	1.222
0.015	384.3	1.015	1.156
0.010	367.4	0.971	1.105
0.005	350.5	0.926	1.054
85% Guar Gum, 12% Sugar, 3% Borax			
0.0665	573.5	1.518	1.718
0.0465	486.3	1.285	1.454
0.0332	436.2	1.152	1.304
0.0233	403.1	1.065	1.205
0.0163	379.6	1.003	1.135
0.0116	366.1	0.967	1.095
0.0083	355.2	0.938	1.062
0.0058	348.0	0.919	1.041

plotted against the gum in solution equilibrium on a logarithmic scale. While the sorption isotherms of locust bean and guar gums (Fig. 2) exhibit a slope in accordance with Freundlich's equation, approaching the horizontal in the case of guar at higher concentrations, the two gum-borax blends (Fig. 4) show no concentration dependence within certain concentration limits. They do not follow the adsorption isotherm because in their case we are not dealing with adsorption on the surface only, but with a physical-chemical bond in addition to adsorption.

Dilution experiments supported this hypothesis. Sorption of the gum-borax blend remained constant and

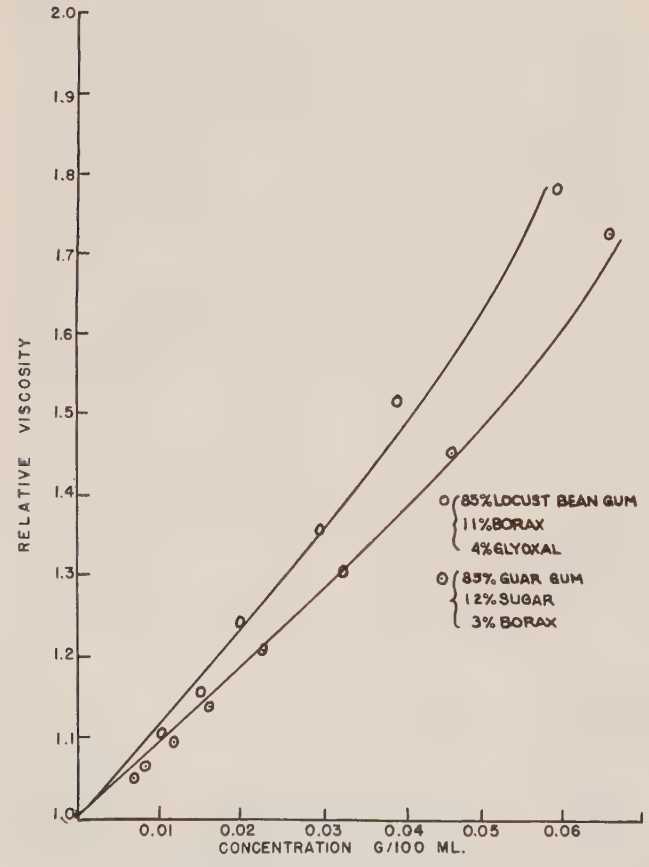


Fig. 3. Gum-borate complex calibration curves

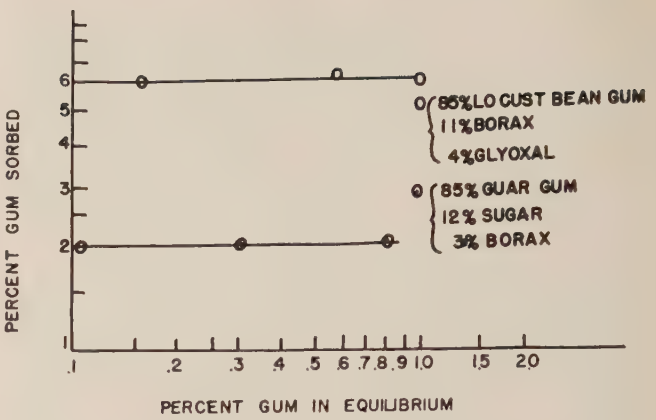


Fig. 4. Gum-borate complex adsorption isotherms

independent of the total volume in which this blend and the fibers were suspended, contrary to the sorption behavior of the unmodified gums.

Where crosslinking is facilitated, as by the di-diol gum complex, sorption will be more stable, will not be influenced by dilution, and will be independent of the gum concentration within certain limits. These limits are determined by the fact that there is always some degree of adsorption on the surface of the fibers.

Kletzl (*11*) presented some interesting sorption data. In making use of Freundlich's adsorption isotherm he presented a logarithmic plot of adsorption curves of several dyes and showed that direct dyes do not follow the adsorption isotherm. Because of the presence of a "chemical bond" they approach a horizontal line in the logarithmic plot of adsorbed versus equilibrium concentration. The direct dye used was Congo red and as the author pointed out, due to the presence of partial valences on this dye and the paper fibers, particularly lignin-free fibers, hydrogen bonding takes place in addition to some adsorption on the fiber surface.

More recently Centola and Borruso (*12*) pointed out that when different pulps (coniferous commercial bleached kraft, strong sulphite pulp, or purified cotton linters of acetylating grade) were beaten in the presence of Congo red, an appreciable increase in the beating rate and simultaneously in the strength properties of laboratory hand sheets was noted.

The similarity in behavior of Congo red and the mannangalactan gum-borate compounds is evident. Both showed the same type of deviation from Freundlich's adsorption isotherm and increased the strength properties of both laboratory and mill sheets, speeding up the beating cycle considerably.

The three-dimensional structure of the di-diol polysaccharide complex with its labile net-forming center

Table V. Gum-Borate Complex Sorption Data

Temperature: 72° ± 3°F.

Experiment	*Original concentration*		*Residual concentration*		*Sorption*	
	%	*Lb./ton pulp*	%	*Lb./ton pulp*	%	*Lb./ton pulp*
85% Locust bean gum	1.600	32	1.00	20	0.60	12
11% Borax	1.200	24	0.56	11.2	0.64	12.8
4% Glyoxal	0.800	16	0.16	3.2	0.64	12.8
85% Guar gum	1.002	20	0.80	16	0.202	4
12% Sugar	0.501	10	0.30	6	0.201	4
3% Borax	0.248	5	0.04	1	0.208	4

and availability of partial valences makes it possible for this complex to enter into the fiber maze and stay there due to hydrogen bonding rather than just align itself to the fiber and stay on the fiber surface.

Another property of gums to be considered and discussed briefly is the electrokinetic charge and its effect upon the system of fibers and mucilages.

Gums are known for their deflocculating effect upon fiber suspensions. Both fibers and mucilages being negatively charged, there is a tendency to stay suspended by mutual repulsion. Upon formation of the di-diol complex of the polysaccharide, the pH is lowered. It seems logical to assume that the negative charge of the complex will therefore increase over that of the unmodified gum, increasing the deflocculating effect. However, no measurements of the electrokinetic charges have been made in our laboratory.

SUMMARY

An investigation has been made of the retention of locust bean gum, guar gum, and their borate complexes on paper fibers.

Retention of unmodified gums has been demonstrated to be a function of the gum concentration, while their di-diol complexes showed a certain independence of the gum concentration.

From these results conclusions were drawn as to the retention mechanism.

In the assumption that hydrogen bonds are mainly responsible for the fiber-gum attraction, it was concluded that a linear gum aligns itself to the threadlike cellulose molecule and is adsorbed on the surface while the more branched or complex gum molecules, due to cross-linking properties, are anchored within the cellulose molecule in addition to some adsorption on the surface.

LITERATURE CITED

1. Broadbent, F. D., and Harrison, H. A., Technical Supplement to the *World's Paper Trade Review* 49–56 (June 27, 1941).
2. Institute of Paper Chemistry, Research Bull. 15, No. 4: 192–208 (1949).
3. Dreywood, R., *Ind. Eng. Chem., Anal. Ed.* 18: 499 (1946).
4. Morris, D. L., *Science* 107, No. 2775: 254–255 (1948).
5. Institute of Paper Chemistry, Research Bull. 16, No. 3: 155–169 (1950).
6. Swanson, John, *J. Am. Chem. Soc.* 71: 1510 (1949).
7. Ahmed, Z. F., and Whistler, R. L., *J. Am. Chem. Soc.* 72: 2524 (1950).
8. Hart, Ralph, *Ind. Eng. Chem., Anal. Ed.* 2: 329 (1930).
9. Tuzuki, Joziro, *Bull. Chem. Soc. Japan* 13: 337 (1938); 15: 27 (1940); 16: 23 (1941).
10. Deuel, H., and Neukom, H., *Makromol. Chemie* 3: 13–30 (1949).
11. Kletzl, Karl, *Wochenblatt für Papierfabrikation* No. 12: 337–344 (1950).
12. Centola, G., and Borruso, D., *Ind. Carta* (Milan) 6, No. 4: 41–47 (April, 1952).

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The Chemical Composition of Grand Fir Bark

E. F. KURTH and GEORGE M. TOKOS

Samples of grand fir bark were collected from the top, middle, and bottom sections of ten trees divided into three age groups: 165 to 170 yr., 196 to 225 yr., and 245 to 257 yr. The nine samples were successively extracted with hexane, benzene, ethyl ether, hot water, and alcohol to show the distribution and amount of extractives. Analysis showed the hexane-soluble material to be principally a wax. The benzene, ether, and alcohol-soluble materials were obtained only in small yields and were not further investigated. The tannin content was 7.13% of the oven-dry weight of unextracted bark. A carbohydrate material, obtained from the hot-water extract, contained 17.7% tannin, 8.2% of an insoluble material, 15.6% uronic anhydride, 15.72% pentosans, 1.1% mannan, and other hexosans. A gum was obtained from the hot-water extracted bark residue by additional extraction with 0.5% ammonium oxalate solution. This material was found to contain 14.0% mannan and 48.3% of uronic anhydride which apparently was galacturonic anhydride; its specific optical rotation was + 175°. The extractive-free bark residue contained 40.4% lignin and 59.5% holocellulose.

Inasmuch as the United States is dependent on imports to meet its essential requirements of vegetable gums and tannin, these materials have been in short supply for the past 10 years, or longer. In their investigations of balsam fir bark, Hay and Lewis (*6*), as well as Graham and Rose (*5*), found tannin and a mucilage or gumlike substance. This species is not found in quantity in the Pacific Northwest, but grand fir (*Abies grandis*, Lindl.), another true fir, is cut for lumber and pulpwood in the Pacific coastal region from Vancouver Island in Canada to western California, and from Washington and Oregon to northern Idaho and western Montana. While an analysis of the wood from this species has been reported (*11*), no previous investigation of the bark could be found in the literature. It was decided, therefore, to investigate the constituents of this bark.

E. F. Kurth, Chief, Chemical Research and Development Division, Oregon Forest Products Laboratory, and Professor of Wood Chemistry, Oregon State College, and George M. Tokos, Graduate Student, Department of Chemistry, Oregon State College, Corvallis, Ore.

SOUND AND PREPARATION OF SAMPLES

The bark for the experimental work was collected in June, 1950, near Oakridge, Ore., from trees that grew at an elevation of 4000 ft. and were felled within 1 week of the sampling. The age of the trees ranged from 165 to 257 yr. Samples of bark were taken from the bottom, middle, and top sections of ten trees.

After air drying, the bark was separated into nine composite samples according to age group and section of the tree, as shown in Table I. The samples were ground in a Rietz disintegrator to pass a 20-mesh screen, and the ground bark was stored in glass jars. The average moisture content at time of analysis was found to be 8%.

Table I. Collection Data on Grand Fir Bark Samples

Group no.	Age of trees, yr.	Tree no.	Bottom section diameter, in. Outside bark	Bottom section diameter, in. Inside bark	Middle section diameter, in. Outside bark	Middle section diameter, in. Inside bark	Top section diameter, in. Outside bark	Top section diameter, in. Inside bark
			2.5 to 4.0-ft. height		*42 to 45-ft. height*		*95 to 115-ft. height*	
I	170	34	17.2	15.2	15.8	14.8	9.0	8.6
	165	12	23.8	21.8	15.5	14.3	12.5	11.7
			1.0 to 3.0-ft. height		*44 to 53-ft height*		*85 to 112-ft. height*	
II	196	27	22.5	20.5	17.5	15.8	11.2	10.0
	225	28	29.0	26.8	19.0	18.0	14.0	13.0
	220	29	18.7	17.5	16.8	16.0	8.1	7.5
	218	30	24.9	22.4	21.6	19.1	12.6	12.0
	202	32	31.1	28.6	24.0	22.8	17.2	16.0
			2.0 to 3.5-ft. height		*44 to 68-ft. height*		*96 to 120-ft. height*	
III	255	25	20.0	18.0	15.5	14.1	6.5	5.8
	257	26	30.5	27.2	18.5	17.0	16.0	15.0
	245	31	41.5	39.2	28.8	27.0	18.0	16.5

Location: Willow Creek, south of Oakridge, Ore. T. 22S, R 3 W. Section 32. Elevation 4000 ft.

EXTRACTIVE CONTENT OF BARK

The nine composite samples were extracted with hexane, benzene, diethyl ether, hot water, and alcohol, in that order, to show the distribution, nature, and amount of the extractives present in the bark. Hexane removed the fats, oils, and waxes; benzene the hydroxy acid-type waxes insoluble in hexane (*8*); diethyl ether any flavones or similar crystalline, coloring matters (*12, 14*); hot water the tannin and soluble carbohydrates; and alcohol the phlobaphenes. All extractions, with the exception of the hot-water extractions, were made in glass Soxhlet extractors, where accurately weighed samples of about 30 grams of bark were placed in cloth bags and extracted continuously with the solvent for about 8 hr. The solution was filtered into a tared glass dish and evaporated to dryness in a steam bath. The dish and residue were then placed in an oven at 105°C. for 8 hr., cooled in a desiccator, and weighed. In the hot-water extractions, TAPPI method T 1 m-45 (*17*) was followed, except that the leaching time was extended to 4 hr. when it was found impossible to filter the solution after the specified 3-hr. extraction period. The residual bark from the hot-water extraction was given a final extraction with 95% ethyl alcohol in a Soxhlet extractor according to the previously mentioned method. The results of these extractions are given in Table II.

Table II. Percentage Extractive Content of Grand Fir Bark

Values Based on Oven-Dry Weight of Unextracted Bark

Age group	Section	Solubles: Hexane	Benzene	Ether	Hot-water	Alcohol	Total
I	Bottom	1.89	0.86	0.40	14.24	1.10	18.49
	Middle	2.23	1.10	0.40	19.07	1.10	23.90
	Top	2.26	1.37	0.15	24.62	0.62	29.02
II	Bottom	2.45	1.95	0.66	12.13	3.35	20.74
	Middle	2.33	0.93	0.76	15.44	2.32	21.78
	Top	2.41	1.17	0.68	17.35	1.80	23.41
III	Bottom	2.53	1.13	1.02	10.97	2.67	18.32
	Middle	2.19	0.97	0.83	11.31	2.96	18.26
	Top	1.55	1.48	0.30	13.46	2.28	19.07

The total extractive content of the bark samples ranged from 18.26 to 29.02%. While the highest concentration of extractives was found in the bark from the top sections of the youngest age group, distribution was quite uniform throughout all sections of the two older age groups. The hot-water solubles were present in the greatest quantities in all samples.

Only the hexane and hot-water solubles were present in sufficient quantities to warrant further detailed investigation. Among the others, the benzene extract was a soft, black, resinous material, and the diethyl ether extract a dark red, tanninlike substance. Their appearance did not vary between age groups or sections. The alcohol-soluble material was considered to be essentially phlobaphene.

CONSTITUENTS OF THE HEXANE EXTRACTIVE

The hexane-soluble material was a soft wax, yellowish-green in color in the extracts from the top bark sections, light tan in those from the middle sections, and of a reddish tint in those from the bottom sections.

A composite sample of bark, made up of equal parts from all nine samples, was used for subsequent analyses. From this composite sample, three batches of 500 grams each were extracted in a large glass Soxhlet. The yield of extract was 2.20% based on the oven-dry weight of materials. This extract was a light tan wax with a melting point of 52 to 53°C., as determined by the drop point method (*2*).

Two additional composite samples were extracted with benzene, in lieu of hexane, in the Soxhlet extractor for 12 hr. After removal of the solvent, the extract was dried and weighed. The percentage of hexane-soluble wax in this benzene extract was determined by successive leachings with hot hexane. The hot hexane solution was filtered, the solvent removed by distillation, and the yield of wax determined. The average yield of hexane-soluble wax from the two samples was 2.16% which is in close agreement with the 2.20% obtained by extracting the bark directly with hexane. The yield of total benzene-soluble matter was 3.6%.

The hexane-soluble wax was investigated further to find the nature of its constituents. Unsaponifiable matter was determined according to the method of AOAC (*3*). Separation, purification, and determination of the wax acids were carried out in accordance with the procedure used for Douglas-fir wax (*11a*). The neutral equivalent of the wax acids was determined in a solvent composed of equal volumes of alcohol and benzene (*16a*). After saponification of the wax and separation of the wax acids and alcohols, there remained 9.9% of a dark colored resinous matter insol-

Table III. Wax from Grand Fir Bark[a]

Analytical Values Calculated on the Moisture-Free Basis

	Bark sample No. 1	Bark sample No. 2
Bark extracted, grams	656.2	588.5
Total benzene solubles, %	3.52	3.67
Hexane-soluble wax, %	2.20	2.11
Unsaponifiable matter in hexane-soluble wax, %	27.36	28.80
Hexane-soluble wax acids, %	42.58	40.80
Resinous matter insoluble in hexane after saponification, %	9.92	9.96
Neutral equivalent of wax acid	357.9	357.6
Melting point of wax acid, °C.	70–71	71–72

[a] Data furnished by Frank Chan, Analytical Chemist, Oregon Forest Products Laboratory.

uble in hexane. The analytical data are shown in Table III.

The wax acid fraction after recrystallization from acetone and hexane was obtained as white fine crystals, m.p. 71 to 72°C. and neutral equivalent 358. It gave a negative Liebermann-Storch test for resin acids and a negative test for unsaturation with cold permanganate solution. On the basis of these properties, it was identified as lignoceric acid.

The unsaponifiable material, after recrystallization from hot acetone and hexane, was obtained also as fine white crystals, which melted at 70 to 71°C. and formed an acetate melting at 53 to 54°C. An oxidative fusion of the alcohol with potassium hydroxide (*7*) gave the corresponding acid, m.p. 73 to 74°C. and neutral equivalent 384. These data indicated that it was a saturated fatty alcohol. No hydrocarbons were found in the unsaponifiable fraction.

CONSTITUENTS OF THE HOT-WATER EXTRACTIVE

Tannin

Attempts at tannin analysis using the percolation-type extractor recommended by the American Leather Chemists Association (*1*) were not successful, for after $^1/_2$ hr. of operation, a gelatinization of the bark occurred and the liquor would not drain from the sample. Graham and Rose (*5*), who experienced the same difficulty with balsam fir bark, attributed the gelatinization to the presence of a pectinous material. The liquor from the grand fir bark, which was obtained before the gelatinization took place, was analyzed for tannin in accordance with the standard methods of the American Leather Chemists Association (*1*). The results of this analysis appear in Table IV.

Table IV. Percentage Tannin Analyses

Values Based on Oven-Dry Weight of Unextracted Bark

	20-mesh sample, 1/2-hr. water extraction	*20-mesh sample, alcohol extraction*	*4-mesh sample, 10-hr. water extraction*
Total solids	12.14	15.33	15.55
Soluble solids	11.75	11.22	14.55
Insoluble solids	0.39	4.13	1.00
Nontannin	5.39	4.66	7.42
Tannin	6.36	6.56	7.13

In an attempt to avoid the gelatinization, another percolation extraction was made with 95% ethyl alcohol instead of water, using an extraction time of 8 hr. The alcohol was evaporated from this extract at room temperature and replaced with water. The aqueous solution was analyzed for tannin by the official hide powder method; the results appear in Table IV.

A third percolation extraction was made with water on a sample of bark, which had been ground to pass a 4-mesh instead of a 20-mesh screen. Using this coarse bark, the previously reported gelatinization did not occur, and the liquor drained from the sample in a normal manner. The tan liquor obtained had a dark red color. The optimum time for tannin extraction was found to be 10 hr., after extracting coarse bark samples for different periods of time ranging from 4 to 14 hr. The liquors from all these experimental extractions were analyzed for tannin; the 10-hr. period gave the maximum amount. Results of the tannin analysis on the coarse bark are included in Table IV.

The results show that the tannin content of grand fir bark is approximately 7.0%, 89% of the total tannin being removed from the bark in the first 30 min.

Carbohydrate Material

A large quantity of the hot-water extractive was desired for further investigation of its constituents. Thirty pounds of the composite unextracted bark sample were extracted in wooden kegs for 4 hr. with water at 90 to 100°C. The water was maintained at this temperature by steam coils located in the bottom of the kegs. The liquor was then drained off, fresh water added, and the leaching operation repeated two more times. A total of 5.28% water solubles was extracted. The liquor collected from the extractions was evaporated to a thick sirup in a vertical, long tube, natural circulating-type, vacuum evaporator. The sirup was added to four volumes of 95% ethyl alcohol, and the resulting precipitate washed with alcohol until the alcohol remained colorless. The precipitate was then redissolved in hot water and again precipitated with alcohol. The new precipitate was filtered on a Buchner funnel and dried in a vacuum desiccator to a moisture content of 8%. The yield of light tan powder was 2.36% of the oven-dry weight of unextracted bark.

A 5-gram sample of the product was dissolved in 300 ml. of water and analyzed for tannin by the hide powder method of the American Leather Chemists Association. The tannin content was 17.7% of the oven-dry weight of the material, indicating that the material was not a pure carbohydrate, and that the bark tannin was not entirely soluble in alcohol.

The residual detannized solution from the tannin analysis was refluxed with 2% sulphuric acid solution for 14 hr. and filtered. A 14-hr. hydrolysis period gave the maximum amount of reducing sugar, 47.7%. A black, amorphous, insoluble substance, apparently lignin or phlobaphene material, was obtained in an 8.2% yield.

Further analysis of the light tan carbohydrate precipitate from the hot-water extract indicated the presence of 1.1% mannan. A uronic anhydride determination, by the method of Maher (*15*), showed a yield of 15.6%. A pentosan determination, corrected for the uronic anhydride present (*16*), indicated the presence of 15.72% pentosans. Treatment with 25% nitric acid gave mucic acid. These tests indicated that it was a polyuronide, possibly with galacturonic acid residues.

Gum Material

The residual bark from the previous hot-water ex-

traction was then extracted twice with a 0.5% solution of ammonium oxalate at 80 to 90°C. for 3 hr. The liquor obtained from these extractions was concentrated to a thick sirup by vacuum evaporation, then added to 3 volumes of 95% ethyl alcohol, and acidified with hydrochloric acid to decompose the oxalate. A carbohydrate gum precipitated from solution.

The gum was filtered from the solution, re-dissolved in water, reprecipitated with alcohol, and then washed with alcohol to complete the removal of ammonium chloride and oxalic acid. The crude gum was again dissolved in water, the solution slightly acidified and warmed on a steam cone for 1 hr. A black precipitate, constituting 12% of the crude gum, separated out and was removed by filtration. When the filtrate was added to 3 volumes of alcohol, a dark orange precipitate separated. It was recovered by filtration and redissolved in water. Bromine was added until the solution was yellow in color, and the solution was heated in a steam bath for $^1/_2$ hr. The gum was then reprecipitated with alcohol, recovered by filtration, and dried in a vacuum desiccator. The yield of semitransparent gum was 1.37% of the oven-dry weight of bark.

A 5% solution of the purified gum in cold water gave a viscous gel. Using a sodium lamp, the specific optical rotation of a 0.4% water solution of the gum at 25°C. was +175°. A thick paste of the gum proved to be an effective adhesive for paper.

A chemical analysis of the gum indicated the presence of 48.3% uronic anhydride, 14.0% mannan, and 44.3% total reducing sugar after a 14-hr. hydrolysis period. Treatment with 25% nitric acid gave mucic acid in a yield equivalent to 44.8% galacturonic anhydride.

ANALYSIS OF GRAND FIR BARK BY STANDARD METHODS OF WOOD ANALYSIS

A composite sample of the bark was ground to pass a 40-mesh screen and then analyzed by conventional wood analysis procedures, wherever applicable. Two procedures for the preparation of extractive-free bark were used. By the first procedure, the ground bark sample was extracted successively with ethyl ether, 95% ethyl alcohol, and hot water (*10, 11*). By the second, the bark was extracted successively with alcohol-benzene mixture, 95% ethyl alcohol, and hot water, in accordance with TAPPI method T 12 m-45 (*17*). Results of the two series of extractions are given in Table V. The data show that the second procedure removed 0.62% more extractive than the first. This difference, occurring largely in the hot-water extraction, was believed to have been caused by the gum in the bark.

Table V. Comparison of Methods to Remove Extractives
Percentages Based on Oven-Dry Weight of Unextracted Bark

	Per cent
Ether solubles	3.83
Alcohol solubles	12.65
Hot-water solubles	6.19
Total extractives	22.67
Alcohol-benzene solubles	10.02
Alcohol solubles	6.07
Hot-water solubles	7.20
Total extractives	23.29

The extractive-free bark prepared in accordance with TAPPI method T 12 m-45 was further analyzed for lignin, T 13 m-45; methoxyl, T 2 m-43; acetyl (*4*); and pentosan (*3*). Holocellulose could not be prepared by the monoethanolamine and chlorination procedure, T 9 m (*17*), but was successfully produced by a modification of Jayme's sodium chlorite method (*9, 13, 18*). The analyses are given in Table VI.

Table VI. Percentage Analyses of Grand Fir Bark
Values Based on Oven-Dry Weight of Unextracted Bark

Alcohol-benzene solubles	10.02
Alcohol solubles	6.07
Hot-water solubles	7.20
Ash content	1.80
Lignin	31.01
Holocellulose (corrected for lignin)	45.66
Pentosans	8.02
Methoxyl group	3.40
Acetyl group	0.71

For the holocellulose determination, an extractive-free bark was used, which passed a 40-mesh screen and was retained on a 60-mesh screen. Six treatments with sodium chlorite and glacial acetic acid were necessary. The first two treatments were of $^1/_2$ hr. duration and the remaining four were 1 hr. each. The isolated holocellulose samples were analyzed for residual lignin and found to contain an average of 4.05% lignin, based on the oven-dry weight of extractive-free bark. This value was subtracted from 63.56%, the average yield of isolated holocellulose, to give a yield of 59.51% lignin-free holocellulose.

The ash content of the unextracted bark was determined in accordance with T 15 m-45.

LITERATURE CITED

1. American Leather Chemists Association. Methods of Sampling and Analysis, Cincinnati, Ohio, 1946.
2. American Society for Testing Materials. ASTM Standard including Tentative Standards, Part III, Baltimore, 1944.
3. Association of Official Agricultural Chemists. Official and Tentative Methods of Analysis, 6th ed., Washington, D. C., 1945.
4. Freudenberg, K., and Harder, M., *Ann.* 433: 230–233 (1923).
5. Graham, W. E., and Rose, A., *Can. J. Res.* 16B: 369–379 (1938).
6. Hay, K. D., and Lewis, H. F., *Paper Trade J.* 111, No. 25: 39–43 (1940).
7. Heiduschka, A. R., and Repper, J., *Ber.* 56: 1736–1739 (1923).
8. Hergert, H. L., and Kurth, E. F., *Tappi* 35: 59–66 (1952).
9. Jayme, G., *Cellulosechemie* 20: 43–49 (1942).
10. Kurth, E. F., *Tappi* 32: 175–176 (1949).
11. Kurth, E. F., *Tappi* 33: 507–558 (1950).
11a. Kurth, E. F., *J. Am. Chem. Soc.* 72: 1685 (1950).
12. Kurth, E. F., and Hubbard, J. K., *Ind. Eng. Chem.* 43: 896–900 (1951).
13. Kurth, E. F., Hubbard, J. K., and Humphrey, J. D., *Proc. For. Prod. Res. Soc.* 3: 276–283 (1949).
14. Kurth, E. F., and Kiefer, H. J., *Tappi* 33: 183–186 (1950).
15. Maher, G. G., *Anal. Chem.* 21: 1142–1144 (1949).
16. Norris, F. W., and Resch, C. E., *Biochem. J.* 29: 1590–1595 (1935).
16a. Steele, L. L., and Sward, G. G., *Ind. Eng. Chem.* 14: 157 (1922).
17. Technical Association of the Pulp and Paper Industry. Testing Methods, Recommended Practices, Specifications, New York, N. Y.
18. Wise, L. E., Murphy, M., and D'Addieco, A., *Paper Trade J.* 122, No. 2: 35–43 (1946).

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Development of 65% Yield Sulphite for Newsprint Furnish

F. P. SILVER and L. R. BEATH

Rising wood costs increasingly emphasize the importance of higher yields in chemical pulps. A mill-scale pilot plant which has produced news-grade sulphite pulp of 63 to 65% yield for nearly 3 years is described, together with operating conditions and results. Extensive commercial tests proved that the pulp was entirely satisfactory for newsprint furnish, and that newsprint made with it is fully equal to that made with normal yield sulphite. A brief description is given of the plant now under construction to provide full sulphite requirements as high yield sulphite for manufacture of over 700 tons per day of newsprint.

At the 1949 meeting of TAPPI, Hill and coworkers first described the curlation process and its unique ability to defiber pulp shives without loss of freeness or cutting of fibers. A companion paper by the senior author of this paper dealt with a commercial application of the curlation process by which 10% more sulphite pulp was obtained per cunit of wood. In that paper it was indicated that the process, and the machine developed to do the process, the Curlator, could be expected to provide the key to the production of good quality sulphite pulp for newsprint at pulp yields above 60%. This expectation has since been proved sound.

Our original experimental model Curlator, described in the earlier paper, operated in mill service for 8 months. It was replaced in June, 1949, by a commercial model Curlator operating in a similar system and has produced very satisfactory results since that time. Briefly, operation of this Curlator allowed an increase in total yield from the digesters from 48 to 52% and resulted in an increase in no. 1 sulphite yield from 45.6 to 50.9%. There was therefore a wood saving of approximately 10% with corresponding economies in steam, sulphur, and limestone without noticeable change in product quality.

With the system described in the earlier paper it was found, at yields over 53%, that large numbers of thin, soft, white shives were present in the feed stock to the screens. Too many of these were accepted by both rotary and flat screens and passed into the accepted stock, escaping the Curlator treatment. It was necessary, therefore, to keep the yield below the point at which they were present in objectionable numbers. This factor set the upper limit of yield for the system.

To obtain still higher yields with good quality required passing all the sulphite through Curlators before screening. The large investment required to do this could only be made attractive by a further large increase in yield—to somewhere in the 60 to 65% yield range. It was expected that the cooking, blowing, and processing of sulphite pulp of 60 to 65% yield would require new techniques, and that considerable investigation would be necessary before commercial production would be possible at these yields. Assurance was also required that the pulps would be suitable for newsprint furnish, both with respect to operating properties on the paper machines and to quality of the finished newsprint. Laboratory scale high yield cooks made by the research department indicated the general nature of cooks in the 65% range, and strongly suggested that the product would be suitable for newsprint. Complete assurance could only be had by mill-scale trials.

It was therefore decided to set up a mill-scale, high yield system for experimental operation, entirely separate from the original Curlator system. The twin objectives were: first, to produce sulphite at 60 to 65% yield, or higher, suitable for newsprint furnish; and, second, to manufacture newsprint with this sulphite as a final check on its value. It is the major purpose of this paper to describe the experimental pulping system installed, its operation, and the results obtained.

EXPERIMENTAL HIGH YIELD SYSTEM

Figure 1 shows the experimental system setup for the high yield sulphite work. Pulp was cooked in a digester (1) which had been modified by installing nozzles around the top of the lower cone. A pump (2) supplied hot high pressure waste liquor to the nozzles to prevent hang-ups during blowing. This pump drew on liquor stored in the second digester (3). The cooking digester (1) is provided with a Y in the blow line to permit blowing into either of two blowpits (4 and 5), so that the refining system did not need to be shut down while a pit was being washed. At this point it should be explained that the material in the pits, at around 65% yield, is not stock or pulp in the usual meaning of those words. This material consists of softened whole chips mixed with chips disintegrated into pieces ranging in size from match sticks through long coarse shives down to a small proportion of individual fibers. The stock, after washing in the blowpit, went, via pumps (6) to a constant head flow box (7) from which it flowed to a hammermill-type shredder (8). It was originally pumped to a Jonsson knotter (9) with $^1/_4$-in. perforations. Rejects from the knotter were lapped for wrapper furnish. Knotter accepted stock was then pumped to an inclined wire (10) where it was thickened to about 4% for storage in tank (11). Later, the knotter was removed as there was no significant difference in cleanliness between the accepted and rejected streams. For the balance of the trial period stock went directly from the shredder to the inclined wire.

The thickened stock was originally pumped through a Claflin (12) from which part of the stock dropped into the Curlator feed tank (13), while the balance was recycled. The Curlator feed tank was provided with agitation to get blending of the deckered groundwood which was added at this point to improve the processing characteristics of the stock. From this tank the stock was pumped to the second Curlator (14).

The feed stock, at about 4% consistency, was further thickened in the Curlator to about 20 to 25% for treat-

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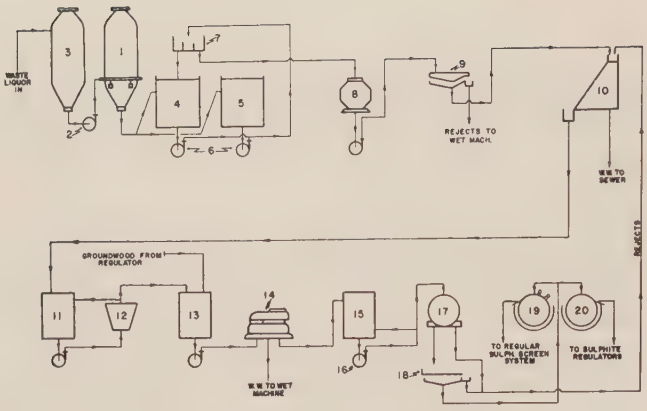

Fig. 1. Flowsheet of experimental 65% yield sulphite system at Riverbend mill

ment. Treated stock and white water issued from the machine in separate streams. Since there is some concentrating of dirt in the white water this has at times been sent to the wet machines for wrapper furnish. The nodulated stock, diluted with fresh water or Curlator white water back to about 4% consistency, was pumped to a denodulating chest (15) in which it was circulated by a pump (16) to break up the nodules formed by the Curlator. The same pump also supplied treated stock to a Waterous 42-in. Quiller screen (17) with 0.055-in. perforations. Rotary screen accepted stock was rescreened on two lines of two Sherbrooke flat screens (18) in parallel. The first screen of each line had 0.008-in. slots and the second, 0.007-in. Stock accepted from the flat screens went to a washer filter (19) where it blended with regular news sulphite accepted from the knotters. This was done to provide extra washing over that given the rough stock in the blowpits. The mixed high yield and regular yield stocks from the washer formed the feed for the normal yield sulphite system. Rejects from the high yield sulphite rotary and flat screens were combined and returned to the inclined wire (10) for reprocessing through the Curlator.

When high yield sulphite was required separately from regular sulphite for trials in newsprint, the flat screen accepted stock was thickened on an American filter (20) for storage ahead of the mixers. The washer and regular mill screening system were thus by-passed.

In a later change, the Claflin was removed from service on the Curlator feed stock and was used to brush out some of the shives in the stock discharged from the Curlator. These shives, having been highly twisted and flexed, were easily defibered. With the Claflin in this latter location system operation and capacity were somewhat improved.

EXPERIENCE WITH HIGH YIELD SULPHITE SYSTEM

The experimental high yield system was put into operation early in February, 1950. It had been intended to start with relatively low yields and work up, tackling the expected problems as they arose. An error in cooking the first digester resulted in a pulp with a 20% chlorine number, or about 60% yield. As this was processed without difficulty, the gradual approach was dropped. Most subsequent cooks have been in the 24 to 28% chlorine number range, corresponding to 64 to 68% total yield from the digester.

It was found, by experiment, that the desired higher yields were best obtained by a small reduction in maximum temperature and cooking time combined with earlier pulldown of digester pressure. Variations in the digester pressure schedule have proved a simple and reliable means of yield control: chlorine numbers of individual cooks are usually within 1 or 2 units of the desired average.

Representative temperature and pressure curves are given in Fig. 2 for regular yield and high yield cooks. The same cooking acid, averaging 8.0% total and 1.03% combined sulphur dioxide was used for both types of cooks. The wood used for high yield cooks was a spruce-balsam mixture and included all the rotten wood culled from the woodroom. Although this culled wood has run from 5 to 20% of each digester charge, the processed pulp has been of very good cleanliness.

Blowing

To insure clean blows with the high yield cooks, six Pelton-type nozzles were installed just above the bottom cone of the digester. The location and design of these nozzles are shown in Fig. 3. Hot waste liquor, stored in a second digester, was pumped by a 2000 U.S. g.p.m., 325-ft. head pump to the header into which the nozzles are connected. Liquor flow to the nozzles was started immediately before the blow valve opened and continued for 5 minutes after it was closed. Backshot steam was then added and the liquor blown out. With this system, cooks up to 30% chlorine number have been blown without hang-ups. Installation of a Y in the blow line to permit blowing into either of two pits caused no hang-up trouble. Prior to installing this flush-out system it was impossible to blow clean with pulps of over 14% chlorine number.

Handling in the Blowpits

The high yield cooked chips were washed in the regular way in the blowpits with good results. Pulp pH,

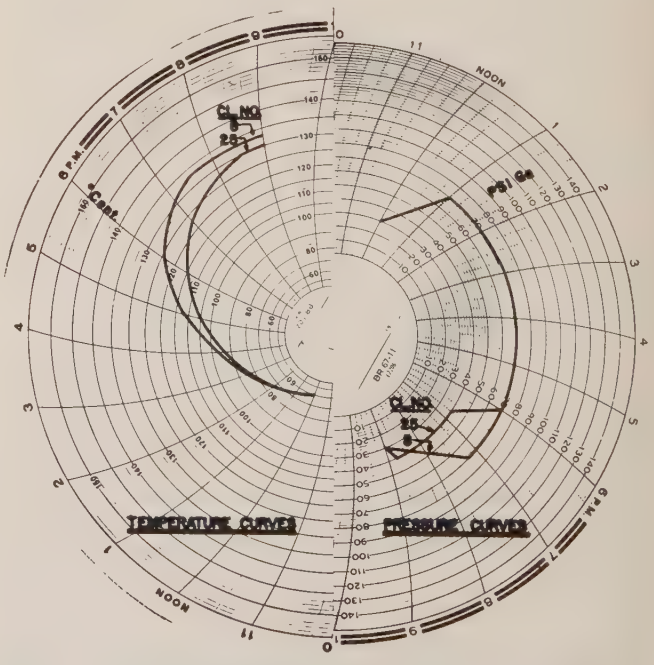

Fig. 2. Temperature and pressure curves for cooking 52 and 65% yield pulps at Riverbend mill

without other washing, was 5.0 to 5.5. Although the chippy, high yield pulp settles out of suspension much faster than ordinary pulps, there was no trouble in sluicing it from the blowpits.

Preliminary Pulping and Knotting

The preliminary pulping step was originally done by a hammermill having $^3/_4$-in. screen perforations. This unit reduced chips and knots alike to a maximum size about that of match sticks.

As mentioned before, knotters were found to be unnecessary. High yield knots are very nearly as light in color as the chips and were equally well defibered by the equipment used.

It was believed that further size reduction of the high yield stock ahead of the Curlator would increase the capacity of that unit. Accordingly, the defibering action of several refiners on the chips was investigated in trial runs. On the basis of these tests the Sprout-Waldron 36-2 disk refiner was selected for mill trial in the experimental system. It was installed to do, in improved fashion, the functions of the hammermill (8) and Claflin (12) of Fig. 1. A high degree of pulping was obtained with this unit and the resulting improved quality of the Curlator feed stock made it possible to increase the net throughput of the Curlator from the prior 16 to 18 tons per day to 20 to 24 tons. The better reduction obtained with the Sprout-Waldron unit also made it possible to decrease the groundwood content of the Curlator feed by 60 to 75% with equally good Curlator operation and a reduced system load.

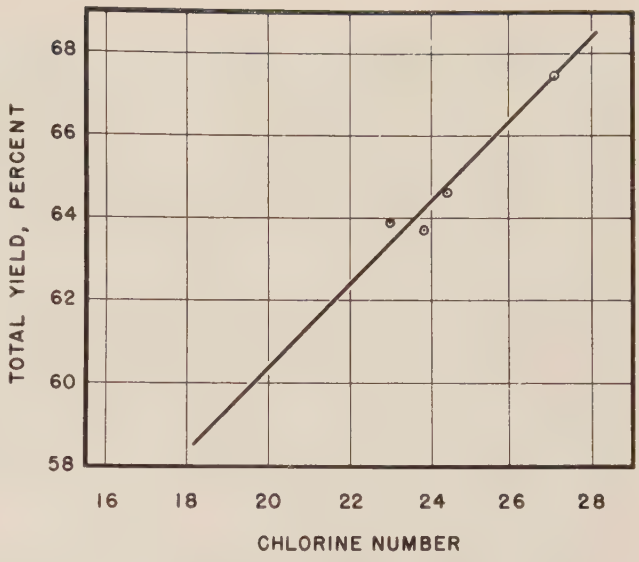

Fig. 4. Chlorine number versus yield relationship

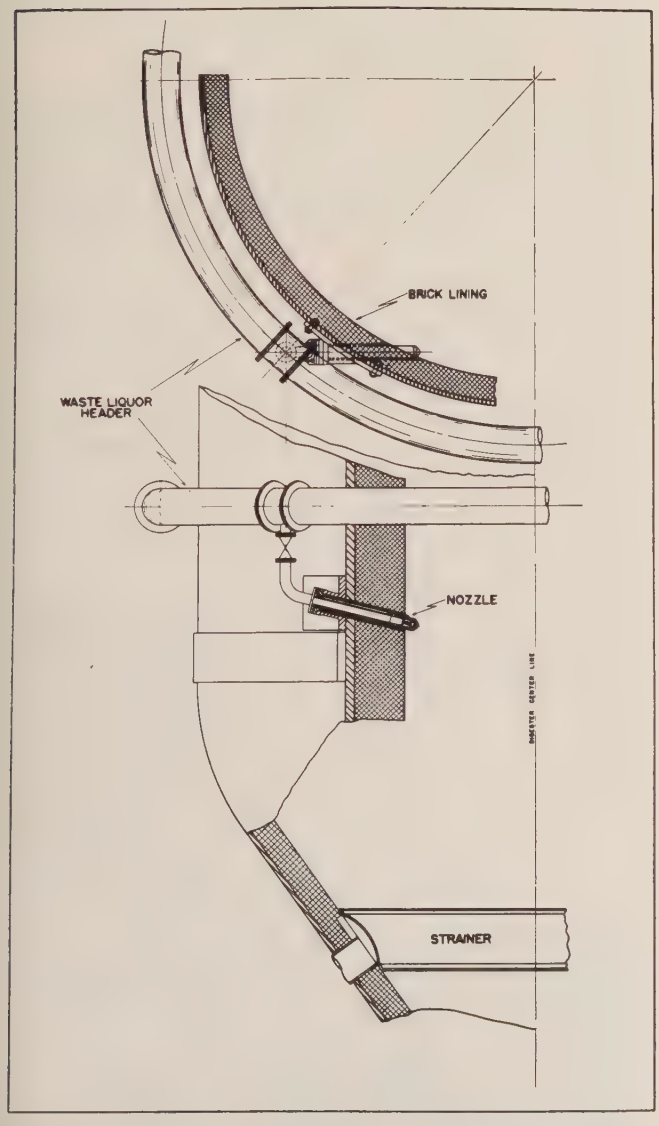

Fig. 3. Arrangement of digester flush-out nozzles

Curlation

From the earliest trials it was necessary to add groundwood to the Curlator feed stock in order to get good operation. In the absence of groundwood the high yield pulp tends to adhere to the working surfaces of the Curlator and develops a shear plane within the pulp, stopping the essential tractive, rolling action of pulp nodules which is the defibering mechanism. Most other pulps, however, can be curlated without adding groundwood.

With the relatively coarse feed pulp from the hammermill it was necessary to add sufficient groundwood to give over 20% of this pulp in the screened stock. With the Sprout-Waldron doing the preliminary reduction the corresponding figure is 5 to 10%, and it is hoped that it will be possible to eliminate it completely. From experiments conducted last November it is hoped groundwood will not be necessary on yields of 70% and over.

Stock feed rate to the Curlator with Sprout-Waldron processed stock averages about 28 to 30 air-dry tons per day of which 1.5 to 2 is groundwood, 4 to 6 tons are screen rejects, and the balance, 20 to 24 tons, is the net high yield sulphite throughput of the system. Power input to the Curlator is approximately 65 hp., or about 3 hp.-days per air-dry ton of production.

Curlator maintenance originally consisted largely of changing the working surfaces at 4 to 6-week intervals. These plates were originally milled from brass and the small pyramids covering the surfaces became dulled and allowed the pulp to skid. Cast surfaces have been used for the past year without appreciable wear. Apart from accidental breakage, a service life of 2 to 5 years is expected from these plates.

Pulp Screening

The high yield sulphite was found to screen in normal fashion. The system was originally started with stock from the Curlator going directly to the rotary screen. This arrangement caused trouble due to the presence of undispersed nodules in the stock, resulting in high screen rejects and generally poor operation. Addition of the denodulating tank to the system completely cured this trouble.

At time of writing, a few preliminary tests have been made in which a 4 by 4 Centri-cleaner was used on rotary accepted stock as an alternate to the flat screens shown in Fig. 1. This unit was kindly loaned for trial by Bauer Brothers. Early results seem to promise a cleaner final product from the Centri-cleaner than that obtained from flat screens.

Results of Operation

The experimental high yield system was put into operation early in February, 1950, and ran almost constantly until the end of 1952, when it was shut down to permit change-over of the balance of the sulphite mill to high yield operation.

Typical performance figures for the high yield system are given in Table I, with comparative data from the regular sulphite system.

Yield figures are for total pulp from the digester against total wood chipped including sawdust which is, however, screened out and burned. In the case of the high yield sulphite, the yield figures are from the curve of Fig. 4 showing the chlorine number-yield relationship as determined by laboratory cooks. Also shown in Fig. 4 are the coordinates of mill-scale yield tests carefully made on each of four cooks. These tests confirm the approximate accuracy of the upper end of the curve.

The yield figures for no. 1 regular sulphite were about one percentage unit lower than the gross yields of the above table due to screenings bleed-off to wrapper. The net yield to newsprint of the high yield sulphite was also lower than the gross yield shown as there was a loss of about 3.7% to the sewer in white water from the inclined wire. The net yield of no. 1 high yield sulphite to newsprint was about 63.5%.

Burst and tearing strength values on the high yield pulp, containing 15 to 20% groundwood, were about the same as for regular sulphite. Making allowance for their higher groundwood content, the high yield pulps showed slightly better tear and burst values than for the regular pulps. Although the presence of varying amounts of groundwood in both sulphites made direct freeness comparisons difficult, the high yield pulp was believed to be freer than the regular sulphite.

Table I

	1951, Month of					
	March		June		September	
	High yield	*Regular yield*	*High yield*	*Regular yield*	*High yield*	*Regular yield*
Chlorine number at blowpits	25.3	7.2	25.6	7.6	25.5	7.5
Yield, %	65.7	51.2	65.9	50.9	65.8	49.9
Tons air-dry no. 1 pulp/24 hr.	15.9	...	14.4	...	16.1	...
Burst ratio, % pt./lb.	88.9	89.5	81.4	83.2	80.8	81.3
Tear ratio	95	102	107	117	102	131
Groundwood, %	21	3	27	3	26	3

The cleanliness of the high yield pulp was excellent, and color and opacity were good.

TRIALS OF HIGH YIELD SULPHITE IN NEWSPRINT

A number of paper machine trials have been made using high yield sulphite as a replacement for regular sulphite. In these trials the change-over from regular to high yield was always effected without lost time on the machines. All tests were made in the speed range of 1200 to 1250 f.p.m., which was the normal machine speed at the time. In all tests the high yield furnish gave evidence of being freer than regular furnish as more water had to be used in the head box, while the flat box, couch, and press vacuums all dropped slightly. It was generally necessary to reduce drier steam pressure when using high yield sulphite, and a slight drop in steam usage for drying was usually noted, indicating that the sheet with high yield sulphite was dryer leaving the last press.

No data on these tests need be presented since none of the usual paper tests showed any difference of significance between newsprint made with regular sulphite and that made with high yield pulp. The change to high yield sulphite did not itself affect the cleanliness of the sheet, although there was some slight extra dirt as was to be expected from the newly installed piping used for the short and intermittent paper machine trials.

The newsprint containing high yield sulphite was followed through comparative printings in several press rooms. This sheet ran without web breaks, and no differences in printing quality were noted. There was a single exception in which the paper finish was low due to overdrying. This occurred in a paper machine trial which was too short to permit proper adjustment of the paper machine.

Newsprint made with regular sulphite and an equal quantity made with high yield sulphite were stored for release at intervals up to 6 months after making. Mixed cars of the two types of paper were sent to press rooms for comparative printing. No differences in printing or running qualities developed as between the two furnishes during storage.

It has been asked if, in substituting high yield for regular sulphite, equal *numbers* of fibers of the two types of sulphite are required. This, of course, would mean using a greater *weight* of high yield sulphite and so would cancel out the yield saving. Actually, in making these comparative newsprint trials, the *weight* per cent was kept the same for both regular and high yield sulphite. Since the average high yield fiber weighs about 25% more than the average regular sulphite fiber, the *number* of high yield fibers used per unit of paper was only 75% as great as the *number* of regular sulphite fibers. Despite this, a given *weight* of high yield sulphite gave as much of the required drainage and strengthening effects as did an equal *weight* of regular sulphite containing 25% more fibers. It may be mentioned too, that pulp strength results are calculated on a weight basis and that, with fewer fibers in the standard weight test sheet, the high yield pulps give equal or better burst and tear tests.

SUMMARY OF RESULTS

Summing up experience to date with the experimental high yield system the following statements can be made:

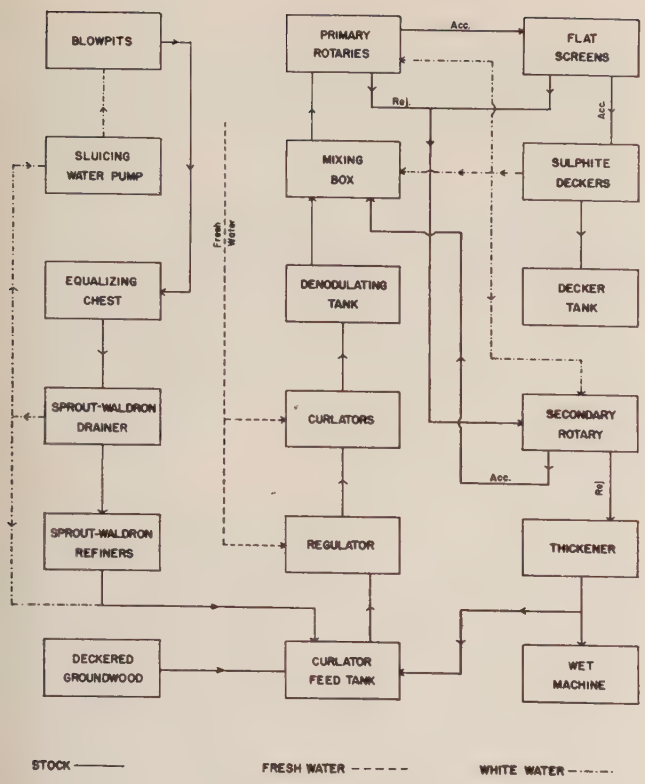

Fig. 5. Flowsheet of 65% yield sulphite system now under construction at Riverbend mill

1. The ordinary bisulphite cooking process can be used to cook chips to 60 to 70% yield with good control of hardness and quality of pulp.

2. Cooks in this yield range can be blown without difficulty by the use of flush-out nozzles properly located in the digester.

3. Chips cooked to 60 to 70% yield are readily reduced to pulp of good strength, freeness, and cleanliness by the refining system described, the key unit of which is the recently developed Curlator.

4. Pulp so produced runs as well on the paper machines in news furnish as does regular news sulphite.

5. Newsprint containing high yield sulphite is, in all respects, the equal of newsprint containing the usual news grade sulphite.

There is, of course, one major, obvious difference between regular and high yield sulphites—their costs. The amount of wood required to produce a ton of newsprint sulphite at the common yield of 47% will produce 1.35 tons at 65% yield. Expressed another way, the wood required for a ton of 65% yield sulphite is 28% less than that required for a ton of 47% yield pulp. What this difference means in terms of annual wood cost savings at any mill is readily calculated. Additional savings, which may run from 5 to 15% of the wood cost saving, can be expected from reduction in sulphur, steam, and limestone consumption.

FUTURE SULPHITE SYSTEM

At present the necessary changes are being made to convert the sulphite mill to the production of sufficient high yield sulphite to supply the full sulphite requirements for newsprint, about 120 air-dry tons per day. The change will result in an annual saving of 10,000 cunits of wood in the Riverbend mill. This wood saving is in addition to a saving of 5000 to 6000 cunits previously made possible by operation of the first Curlator.

The flow sheet for the high yield system, now under construction, is shown in Fig. 5. Cooked chips from an equalizing chest will be thickened on a drainer to about 12% consistency and fed into two Sprout-Waldron refiners for primary breakdown. Each of these refiners has adequate capacity to process the whole chip supply in emergencies although with some loss in the degree of disintegration obtained.

Stock from the Sprout-Waldrons will be diluted with drainer white water to about 4.5% consistency, and about 5% of groundwood added. Rejects from the screening system return for admixture at this point, and the blend constitutes the feed to the Curlators. Eight of these are now at the mill awaiting installation. Present indications suggest that later it may be possible to release one or more of these, probably for a similar installation in our other newsprint mill. After the Curlators, the stock will be denodulated, then screened on rotary primary screens. Accepted stock from these screens may be rescreened on existing flat screens, or may, instead, pass through Centri-cleaners for final stage clean-up. Primary screen rejects will be rescreened by a secondary rotary screen, and the accepted stock will probably be returned to the primary screens. Secondary screen rejects will be thickened and returned, in part, to the Curlators. About 4 tons per day will be lapped to supply commitments for wrapper furnish. Should Centri-cleaners be used, final tailings will also go to the wet machine.

It is expected that this system will be operating about mid-summer of 1953 and all who may be interested have a cordial invitation to inspect it.

RÉSUMÉ

The cooking, blowing, and defibering of sulphite pulp of about 65% yield has been practiced on a mill scale for nearly 3 years. Pulp quality has been proved suitable in all respects for use in newsprint furnish as a complete replacement for ordinary yield sulphite. The quality of the newsprint made with this high yield pulp has proved to be identical with the past standard newsprint as regards all physical tests and, equally important, as regards its running and printing qualities in the press rooms.

As predicted 4 years ago, the Curlator has proved a vital key to the production of high yield sulphite through its unique ability to separate individual fibers from one another without cutting or bruising them, and without reducing the stock freeness. This key unit was jointly developed by the Curlator Corp., Rochester, N. Y., and by Price Brothers & Co., Ltd. but commercialization of the machine is the sole responsibility of Curlator Corp.

This paper is a progress report. It is expected that more will be learned through the commercial operation of the high yield sulphite mill. Provision is being made in the reconstruction for the necessary tanks and piping to permit future operation of a separate mill-scale experimental system similar to the one operated for the past 4 years.

It is believed that by investigation of cooking and defibering variables, the Riverbend mill will ultimately produce its required sulphite at an average yield of 70% or more. It is also possible that it may be feasible

to use wood species other than spruce and balsam with economic advantage and without prejudice to quality. The powerful dispersing action of the Curlator on fibrous dirt should make wood cleanliness a less critical factor and enlarge the scope of wood types acceptable for processing.

PRESENTED at the 38th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 16–19, 1953.

Surface Properties of Rosin Size Precipitate

I. Factors Affecting Formation of Rosin-Aluminum Sulphate Complex

E. F. THODE, J. F. GORHAM, and R. H. ATWOOD

Results of electrophoretic mobility determinations on rosin-aluminum sulphate complex are presented as a means of evaluating factors affecting the surface potential of size precipitate. In the absence of foreign materials, the original negative potential of rosin is found to change rapidly to a positive value with the addition of small amounts of aluminum sulphate. At about a 1 to 1 ratio of aluminum sulphate (anhydrous) to rosin size a maximum positive value is obtained. A subsequent hundred-fold increase in aluminum sulphate concentration has but little effect on this value. Comparison of complex suspensions that have been subjected to violent agitation with those not so treated indicates that, in the absence of foreign materials, the net potential of rosin-aluminum sulphate complex is decreased by such agitation. A hypothetical explanation of this phenomenon, based on the possibility of ion entrapment, is presented. Correlation of mobility results with a limited amount of data on controlled sizing experiments indicates substantial agreement with the theory that the attraction of unlike charges on negative cellulose and positive rosin-aluminum sulphate complex is a major factor in sizing. This theory is but slightly different from the electrostatic theory of Ostwald and Lorenz.

FROM the lack of agreement among the various reports of technical exploration and theoretical reflections in the field of rosin sizing of paper, one may conclude that investigators are hampered in one of two ways in presenting and interpreting their results. In the first place correlations of tests of any kind with actual sizing results are hampered by an uncertainty as to just what factors remain uncontrolled. On the other hand, some excellent recent investigations into basic properties of size have brought extraneous variables well under control only to have the applicability of their results to actual sizing questioned.

A basic premise in the investigation here reported has been that fundamental information into individual factors concerned with sizing and size itself must be gathered and presented, even if the immediate application is not clear. Eventually the facts so gained can be pieced together to give a clear understanding of the mechanism of sizing, thereby enabling the papermaker to gain closer and more economical control of his sizing process.

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It was the purpose of this investigation to determine various effects on a single surface characteristic of the rosin-aluminum sulphate precipitate, namely, the surface potential. Since direct evaluation of this characteristic is not possible, determinations of electrophoretic mobility—which is directly related to the net surface potential, or zeta potential—were undertaken. Simply as a qualitative indication of possible applications, a few sizing experiments were conducted and results compared with mobility results.

THEORIES OF SIZING

Kanamaru (*3*), Ostwald (*5*), and Stockigt (*8*) all have investigated the nature of the rosin-aluminum sulphate complex. Their main findings may be summarized as follows: rosin and pulp fibers are negative in charge, while alumina is usually positive. It has been found that pulp treated with aluminum sulphate becomes positively charged and could attract negatively charged rosin. Rosin treated with aluminum sulphate, moreover, likewise becomes positively charged and could be attracted to the negative pulp fibers.

The use of the term "rosin-aluminum sulphate complex" is considered advisable because of the different theories advanced concerning the structure of the precipitate obtained as the result of various experimental projects. Stockigt and Klingner (*8*), for example, found that the presence of alumina was essential to the production of a sized sheet when using rosin hydrosols. They explained this on a basis that the alumina and the rosin formed an adsorption complex and that this colloidal complex was adsorbed by the cellulose. It is not at all clear from the work of other investigators that *alumina* is an essential part of the complex. Considering the disagreement among those who have worked on the assumption that an identifiable molecular compound—aluminum rosinate (mono-, di-, or tri-)—is essential to sizing it is also not clear that the *aluminum ion* alone is solely responsible for sizing. It appears that the noncommittal term "rosin-aluminum sulphate complex" may be most descriptive in light of present knowledge.

It may be of interest to review briefly the evidence for what may be in rosin-aluminum sulphate complex. Considering first the aluminum sulphate used, it is well known that hydrolysis of its solutions takes place with the eventual formation of a complex precipitate. This

hydrolysis, which is favored by an increase in temperature, gives rise to the effect of aluminum sulphate or alum on pH. It appears from the work of Weiser, Milligan, and Purcell (*10*) that the "alumina floc" formed below pH 5.5 is in reality a basic aluminum sulphate represented by the formula $Al_2O_3 \cdot SO_3 \cdot 1.5H_2O$. The work of Thomas (*9*) in explaining the formation of hydrous alumina as a phenomenon of olation and oxolation of hydrated aluminum ions may also be applied, it would seem, to the material formed in an acid solution. Taken together with the work of Stockigt and Klingner this evidence strongly indicates that "alumina floc" or something much like it is very probably *present* in rosin-aluminum sulphate complex. Evidence that it is not an *essential* part of the complex is equally strong.

The hydrolysis of aluminum sulphate solutions is relatively small compared to the amount of aluminum ions present even at somewhat elevated temperatures. Hester, Bridge, and Harrison (*2*) present results of sizing tests conducted at various temperatures which indicate that for most types of pulps a satisfactory sizing may be obtained at 55°C. as at 25°C. if a constant amount of alum is employed. If, however, a constant pH is maintained by reducing the alum used at elevated temperatures, slack sizing is encountered. Maintaining a constant pH in this manner would keep the amount of "alumina floc" formed constant, presumably, but would considerably decrease the aluminum ion available in the solution. Evidently, the aluminum ion is essential here.

Price (*6*, *7*) has studied the formation of rosin-alum complex extensively and concluded that under some conditions alumina is not present at all. The size precipitate analyzed as aluminum rosinate (probably di-) plus free rosin.

Ekwall and Bruun (*1*) made a study of the reactions of rosin with aluminum by spreading a monomolecular layer of rosin acid on the surface of water or aqueous solutions and measuring the changes in surface tension as concentration of potassium alum in the solution was varied. Analysis of the reacted substance indicated that it was essentially aluminum monorosinate.

Returning to the work of Ostwald and Lorenz (*5*) it should be noted that their theory of sizing based on the mutual attraction of unlike charges does not rule out any of the possibilities for the structure of the complex noted above. In order that there be a positive size precipitate to be attracted to negative cellulose it is only necessary that there be excess aluminum present in the complex over and above that required to satisfy the negative charges of the rosin. Whether this is present as aluminum ion adsorbed on rosin, as a definite compound (aluminum rosinate), or as an alumina-rosin complex is immaterial to this theory of sizing.

EXPERIMENTAL PROCEDURE

Electrophoretic mobility determinations reported here and in the succeeding paper were performed in a Northrop-Kunitz microcataphoresis cell. Dark field illumination was provided by a 200-w. tungsten bulb focused into the cell by means of a substage paraboloid condenser. The magnification of the optical system was 260×; the eyepiece of the microscope was fitted with a calibrated reticle.

The actual cell in which measurements were made consists of two rectangular, optically flat pieces of glass, fused together at the edges and uniformly separated by a distance of about 1.0 mm. Provision for admission and withdrawal of size suspension is made by glass tubes fused to opposite ends of the cell; the solution in these tubes also serves as a salt bridge whereby electric potential is applied to the solution in the cell. Fine platinum probe electrodes are likewise fused into the walls at opposite ends of the cell so that precise measurement of the potential across the cell may be obtained. The distance between these electrodes was determined accurately by means of a cathetometer before the cell was put into use.

Determination of the potential across the cell was accomplished by means of a high resistance potential divider and a sensitive, high-speed, recording, electronic potentiometer.

When the optical system is properly adjusted, colloidal particles of rosin-aluminum sulphate complex (in the proper plane) appear as tiny pin-points of light. When constant potential is applied across the cell, these dots of light move across the field in a direction and at a velocity dependent on the sign and the value of the net potential of the particle with respect to the solution, as well as on the applied potential gradient. Observation of the time required to travel a certain distance and of the applied potential enables calculation of the electrophoretic mobility of the material. This factor has the dimensions of microns per second per volt per centimeter. (For a discussion of the significance of this factor, the reader is referred to the subsequent paper in this group.)

In practice, six to ten individual particles were timed traveling in one direction, after which the polarity of the field was reversed and a like number of particles timed in the opposite direction. This was to obviate errors due to possible convection currents or gravity effects. The mean of the mobility values for all particles observed was taken as the mobility figure for the particular size suspension under test. (Rosin alone was absorbed on 0.3 mu quartz particles for determinations of the mobility of the pure material.)

In each instance, the size precipitate was prepared by first dispersing a weighed amount of low-free gum rosin size in sufficient water to give a 5% solution. This solution was then dispersed in a sufficient quantity of water, and dilute aluminum sulphate solution added so that the final solution was always 0.004% in rosin. The final pH was usually 4.5. Commercial iron-free aluminum sulphate analyzing approximately 17% Al_2O_3 (*4*) was employed. Data on aluminum sulphate concentrations are reported on the basis of anhydrous salt.

Variables studied were the free rosin content of the rosin size used, the agitation employed on formation of the precipitate, the concentration of aluminum sulphate, and the concentration of foreign ions. The effects of each of these on the electrophoretic mobility of the complex were noted.

DISCUSSION

Agitation of Suspension

It was noted early in the investigation that the number of particles visible in the microscope field was quite small considering the quantity of precipitate that should

result from the amounts of rosin size and aluminum sulphate added. A rough calculation indicated that not over 5% of the precipitate formed comprised visible particles. The rest was in the form of a collodial suspension too fine to be detected as anything more than

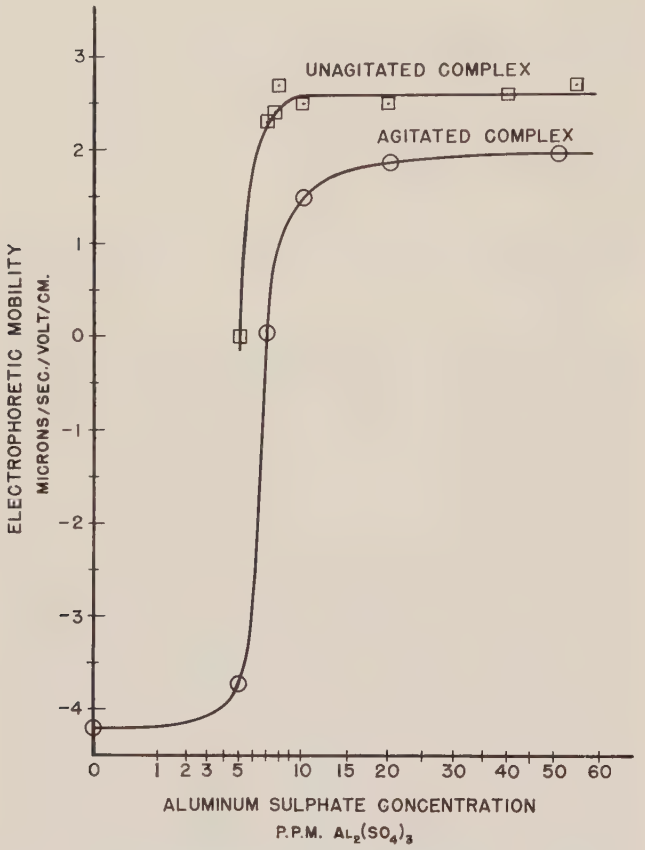

Fig. 1. Relationship between the electrophoretic mobility of rosin-aluminum sulphate complex and concentration af aluminum sulphate, showing the influence of agitation (40 p.p.m. rosin size)

a cloud in the microscope field. (The minimum diameter of resolvable particles was calculated to be about 0.3 mu.) Since there might become question as to whether the small fraction of particles that was visible was representative of the majority of the material, it was determined to enlarge the particle size in some appropriate manner. High-shear agitation in a mixer of the Waring blendor type proved effective.

After 20 sec. agitation, and following appropriate deaeration, the number of visible particles in rosin-aluminum sulphate complex suspension was found to have increased to the point that an estimated 60% of the dispersion was visible in the ultramicroscope field. As may be seen from Figs. 1 and 2, agitation has the effect of reducing the mobility of the complex formed in the absence of foreign ions but has a lesser effect when materials such as magnesium chloride are present.

Alum Concentration

Figure 1 shows the variation of electrophoretic mobility with concentration of aluminum sulphate. The charge on prepared rosin is, as noted by Ostwald and others, negative; the addition of small amounts of aluminum sulphate rapidly reverses this charge so that above 5 to 7 p.p.m. aluminum sulphate (based on a standard concentration of 40 p.p.m. rosin) a positive potential is noted. Above about 10 or 15 p.p.m. aluminum sulphate a constant figure for mobility is reached which thereafter varies but little as the concentration increases. At very high aluminum sulphate concentrations a dropping off in mobility is noted. (Note that a special abscissa scale is employed in Fig. 1 for the purpose of showing greater detail at low concentrations.)

The function shown in the curve is what would be expected if rosin-aluminum sulphate complex were the result of a mere adsorption of aluminum ion on the rosin particles or molecules. However, the formation of a true molecular compound might also be expected to give similar results. It appears that the surface becomes effectively saturated with positive aluminum about the time 10 p.p.m. or so is reached. Further addition of an aluminum salt would not be expected to have any further effect on the net potential (and thus on the mobility)

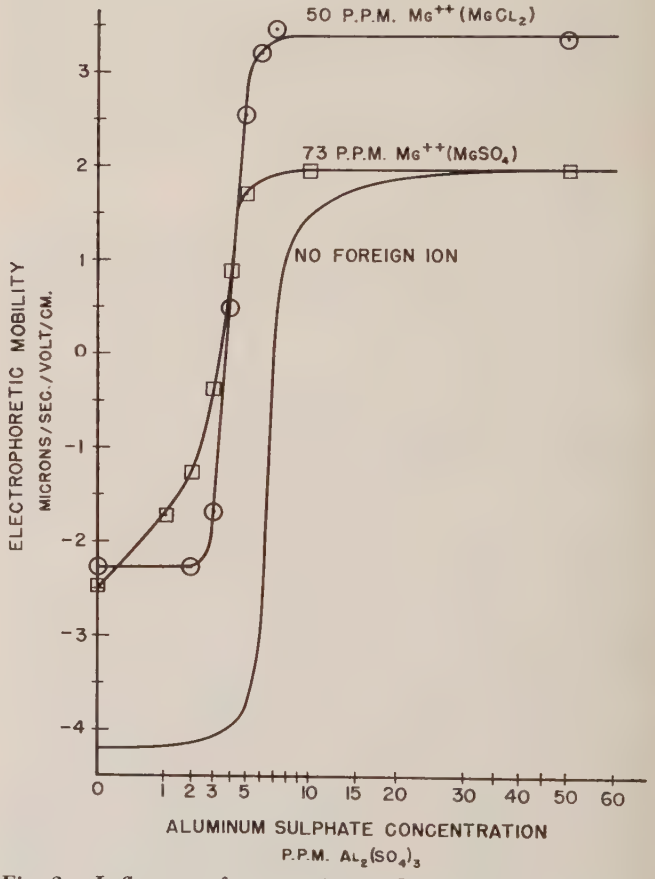

Fig. 2. Influence of magnesium salts on the relationship between electrophoretic mobility and aluminum sulphate concentration (40 p.p.m. rosin size)

of the complex. Apparently, more aluminum ion is adsorbed by the unagitated complex than is held by the complex after agitation.

Effect of Magnesium Salts

In Fig. 2 may be seen the changes in mobility brought about by the presence of magnesium sulphate and chloride in the water. The curve from Fig. 1 for varia-

tion in mobility with aluminum sulphate concentration on agitated complex is drawn in without the data points. Data points are shown for the same relation obtained on agitated complex formed in the presence of small amounts of magnesium chloride and of magnesium sulphate. The observations made on unagitated complex in each case are shown by appropriate entries in

Table I. Effect of Agitation on the Electropheretic Mobility of Rosin-Alum Complex

Foreign material	*Mobility (unagitated), mu/sec./v./cm.*	*Mobility (agitated), mu/sec./v./cm.*
None	3.2	2.0
$MgCl_2$[a]	3.0	2.7
$MgSO_4$[a]	2.2	2.0
$MgSO_4$[b]	3.5	...

[a] In water prior to formation of complex, concentration 0.0001 *N*.
[b] Added to suspension subsequent to formation of complex, concentration 0.001 *N*.
Concentration of aluminum sulphate 0.005%, of rosin size 0.004% in all cases.

Table I as contrasted with the results for the corresponding unagitated complex formed in the absence of Mg salt.

It may be noted that with unagitated complex, the presence of magnesium chloride in the water makes little difference but the presence of sulphate causes a marked drop in mobility. Contrariwise, the presence of magnesium sulphate makes no difference to the mobility of agitated complex, but chloride causes a marked increase. It should also be noted that agitation has little effect on the mobility of complex formed in the presence of these electrolytes, in contrast to the decided drop it causes in the mobility of "pure" complex.

Free Rosin

Mobility determinations on rosin-aluminum sulphate complex formed from various samples of gum rosin

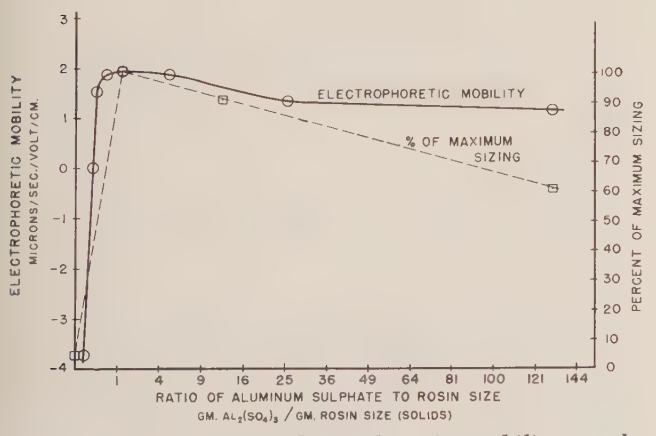
ELECTROPHORETIC MOBILITY
MICRONS/SEC./VOLT/CM.
% OF MAXIMUM SIZING
PERCENT OF MAXIMUM SIZING
RATIO OF ALUMINUM SULPHATE TO ROSIN SIZE
GM. $AL_2(SO_4)_3$ / GM. ROSIN SIZE (SOLIDS)

Fig. 3. Comparison of electrophoretic mobility results with results of handsheet sizing experiments (distilled water used in sheetmaking

ranging in free abietic acid content from 10 to 27% are given in Table II. Little effect of free rosin content on mobility is noted.

Ion Entrapment

Comparison of the data in Fig. 2 with that in Table I, as well as observation of the differences in the two curves in Fig. 1 leads to speculation for the reasons for the marked differences in the mobility (and therefore in the potential) of rosin-aluminum sulphate complex before and after agitation. The differences may be summed up as follows: (1) agitation decreases the mobility of straight rosin-aluminum sulphate complex (2) it has little effect on the mobility of complex formed in the presence of magnesium chloride, and (3) the presence of magnesium sulphate has a depressing effect on mobility of unagitated complex but has no effect whatsoever on that of agitated complex. It may be seen, however, by further reference to Table I that addition of magnesium sulphate to the unagitated suspension *after* the complex has been formed likewise has no appreciable effect on the mobility.

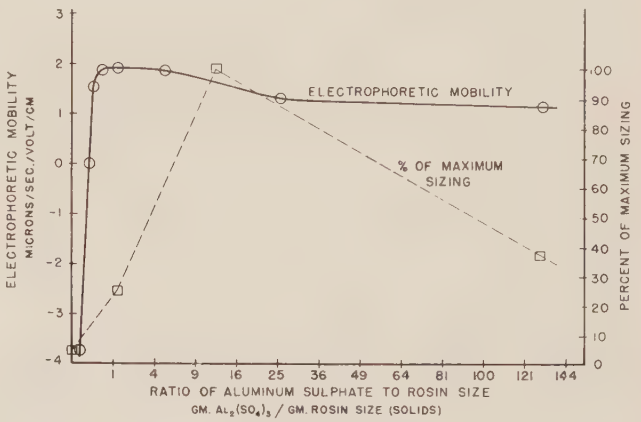
ELECTROPHORETIC MOBILITY
MICRONS/SEC./VOLT/CM
% OF MAXIMUM SIZING
PERCENT OF MAXIMUM SIZING
RATIO OF ALUMINUM SULPHATE TO ROSIN SIZE
GM. $AL_2(SO_4)_3$ / GM. ROSIN SIZE (SOLIDS)

Fig. 4. Comparison of electrophoretic mobility results with results of handsheet sizing experiments (tap water used in sheetmaking)

All these observations may be dismissed as fortuitous circumstance if it is assumed that the particles of unagitated complex are nonrepresentative. While this possibility may not be overlooked, it is felt that the data are too varied to be fortuitous and that a hypothetical explanation may be of some import and is worthy of presentation.

Table II. Effect of Free Rosin Content on the Electrophoretic Mobility of Rosin-Alum Complex

Free abietic acid content[a]	*Electrophoretic mobility, mu/sec./v./cm.*
27.4	1.9
23.0	1.9
18.5	1.9
13.3	1.9
9.5	1.6

Agitated complex used in all cases. Aluminum sulphate concentration 0.005%, rosin size concentration 0.004%. At constant pH of 4.5.
[a] By titration, based on dry solids (*4*).

Whether it be presumed that the formation of rosin-alum complex is a condensation of colloidal particles or the sudden nucleation and rapid submicroscopic crystallization of a particular molecular species, it may be safely postulated that the process gives rise to particles of irregular conformation with the micelles or crystallites rather randomly arranged. If this be the case, it is possible that ions having no place in the structure chemically might be trapped, nonetheless, within the structure. The presence of such entrapped ions, above

and beyond those adsorbed on the surface of the particle, could have a profound effect on the potential of the particle concerned. Now, if it be further assumed that in the process of growth accompanying the high-speed agitation the constitutent crystallites of the particles are rearranged in a more regular order, a means of escape for the entrapped ions is provided.

Applying this hypothesis, the decrease in mobility (and therefore in positive potential) of the straight rosin-aluminum sulphate complex upon agitation may be ascribed to release of entrapped positive aluminum ions. The decrease of mobility of unagitated complex formed in the presence of magnesium sulphate as compared to straight complex can be considered an effect of entrapment of some magnesium ions, of lower positive charge, instead of aluminum ions. It may also be seen why addition of magnesium sulphate after formation of the complex has no effect. The effect in the case of magnesium chloride is masked by the substitution of chloride as contra-ion. This tends to increase the net potential with respect to the solution in any case; it may offset the magnesium entrapment in the case of unagitated complex. With agitated complex the increase is clearly observable.

If this hypothesis is tenable and if the observations noted are characteristic phenomena, the question may be of more than academic interest. It is generally held that extreme agitation of stock after addition of rosin and alum is bad for sizing, although contrary observations have been recorded. Mechanical factors are thought to predominate here, but, in light of the foregoing, is it not possible that agitation of the stock may cause a change in the character of the size precipitate. one facet of which is a decreased positive potential and therefore a lessened affinity for negative cellulose fibers?

Relation of Sizing Effectiveness

The presence of cellulose fiber in the sizing system introduces a variable difficult to control in any attempt to relate mobility results on rosin-alum complex to actual sizing. Figure 3 presents an interesting comparison under conditions attempting to minimize the effect of extraneous variables. Straight rosin-aluminum sulphate complex was formed under conditions similar to those employed in the mobility experiments, agitated in a Waring blendor, and then added to beaten sulphite pulp, in an amount that would give 3% rosin size based on dry weight of fiber. Handsheets were made using distilled water only in the sheet machine; the sheets were pressed according to standard procedure and steam dried for 5 min. at 222°F. The right ordinate axis gives results of ink flotation sizing tests expressed as per cent of maximum sizing. The left-hand ordinate is laid out in units of mobility so that the mobility of straight rosin coincides with minimum sizing and maximum mobility coincides with maximum sizing. The mobility data are replotted from Fig. 1 in terms of a common abscissa with the sizing data. A striking similarity in the shape of the two curves is noted. Lest sweeping conclusions be drawn, however, it should be noted that the test sheets made in distilled water were not very well sized at best. A comparison run was made under identical conditions with the exception of the fact that tap water was used instead of distilled water. The sizing results of this run are compared with mobility data in Fig. 4, using a treatment similar to that of Fig. 3. In this case maximum sizing was of an order considered usual for sheets of this type (about 50 sec.). However, mobility and sizing results do not show the same parallelism as in Fig. 3, although a similar trend is noticed.

It is tentatively concluded from these data that, in the absence of impurities, the charge on rosin-aluminum sulphate complex (as evidenced by its mobility) is related to sizing effectiveness.

The above observation, in effect, lends support to the electrostatic theory of sizing, namely that the attraction of unlike charges (negative cellulose for positive rosin-aluminum sulphate complex) is a major factor in the mechanism of sizing. The theory as stated here is but slightly different from the electrostatic theory of Ostwald and Lorenz.

CONCLUSIONS

The following conclusions are drawn from this work:

1. In the absence of foreign materials, the original negative potential of rosin rapidly is changed to a positive value with the addition of small amounts of aluminum sulphate. At a ratio of aluminum sulphate (calculated as the anhydrous salt) to rosin size of about one to one, a maximum value is attained which thereafter remains substantially constant with increasing aluminum sulphate concentration within the range studied.

2. In the absence of foreign material, the potential of rosin-aluminum sulphate complex decreases after violent agitation of the suspension.

3. Correlation of mobility results with a limited amount of data on controlled sizing experiments indicates substantial agreement with the electrostatic theory of sizing.

LITERATURE CITED

1. Ekwall, P., and Bruun, H., *Finnish Paper and Timber J.* No. 7: 194–202 (1950).
2. Hester, J. A., Bridge, F., and Harrison, H. Ainsworth, *World's Paper Trade Rev.* 128: 487–492, 528–534 (1947).
3. Kanamaru, K., and Tsuchida, T., *J. Soc. Chem. Ind. (Japan)* 36 (Supp. Binding): 102–110 (1933); *C. A.* 27: 3072.
4. Landes, C. G., Private communication (April, 1952).
5. Ostwald, W., and Lorenz, R., *Kolloid-Z.* 32: 119–137, 195–209 (1923).
6. Price, D., *Ind. Eng. Chem.* 39: 1143–1147 (1947).
7. Price, D., *Paper Trade J.* 126, No. 15: 61–66; 127, No. 8: 43–45 (1948).
8. Stockigt, F., and Klingner, A., *Papier-Fabr.* (Fest-u. Ausland Heft) 50–60 (1921); *C. A.* 15: 2984.
9. Thomas, A. W., *Tech. Assoc. Papers* 18: 242–245 (1935).
10. Weiser, H. B., Milligan, W. O., and Purcell, W. R., *Ind. Eng. Chem.* 33: 669–672 (1941).

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Drawn in part from a thesis presented by John F. Gorham to the Faculty of Graduate Study, University of Maine in partial fulfillment of the requirements for the degree of Master of Science in Chemical Engineering, May, 1952.

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Surface Properties of Rosin Size Precipitate

II. *Effect of Foreign Ions on the Electrophoretic Mobility of Rosin-Aluminum Sulphate Complex*

J. F. GORHAM and E. F. THODE

An investigation to determine the effect of foreign ions on the net surface potential of rosin-aluminum sulphate precipitate has been carried out by means of electrophoretic measurements. It was found that the presence of sufficient alkaline-earth sulphates tends to decrease the mobility of rosin-aluminum sulphate complex; the decrease in mobility of the complex is proportional to the concentration of foreign sulphate below 0.1 molal. This decrease correlates with a decrease noted in sizing effectiveness upon addition of foreign sulphates to size systems. In the case of foreign chlorides it was found that the mobility of the complex increases in the presence of many metallic chlorides, within an upper concentration limit of 0.004 molal in most cases. Within appropriate limits, the mobility is a logarithmic function of the foreign cation concentration. The mathematical expression of this function has the general form: $d\mu/dC = K/C$, where μ is the electrophoretic mobility, C is the concentration of foreign ion, and K is an empirical constant evaluated for a given ion. This function is similar in form to an equation for ion adsorption derivable from the Nernst half-cell concentration potential theory. As a result of such similarity, it is tentatively concluded that the variation in mobility noted in the case of addition of metallic chlorides is caused, in part, by the preferential adsorption of the foreign cation on the rosin-aluminum sulphate complex. Experiments with the addition of sodium salts of some high valence anions, which have been found to have a drastically adverse effect on sizing, demonstrate that such materials also bring about a rapid drop in the electrophoretic mobility of size precipitate. As concentration of the foreign anion increases, the positive charge on the size precipitate drops rapidly and soon becomes negative. These results lend further credance to an electrostatic theory of sizing.

DURING the beater sizing process, substances other than water, cellulose, rosin, and aluminum ion invariably are present. These "foreign" substances, other than sulphate ion, are not usually added during the sizing operation, but are present because of some previous treatment of the pulp or because of impurities in the water that is used. It has been established that the presence of certain foreign substances during sizing will substantially affect the degree of sizing obtained.

Many of such foreign substances are present in the form of ions and therefore display electrical properties. Cellulose and rosin-aluminum sulphate complex also display electrical properties in that they are negatively and postively charged, respectively, with respect to distilled water. There exists, therefore, the possibility that the electrical properties of the constituents present during the sizing operation may affect the degree of sizing.

This investigation of the electrophoretic mobility of rosin-alum complex was initiated for the purpose of obtaining a better understanding of the electrical properties of the rosin-aluminum sulphate size precipitate in the presence of foreign ions.

ELECTROKINETIC THEORY

Although the results of this study are reported in the units of electrophoretic mobility, the fundamental property involved in these experiments is the net electrokinetic potential (zeta potential) of the colloidal particle with respect to the bulk phase. The classical treatment of the properties of the electrical double layer was first developed by Helmholtz (*2*) and later modified and generalized by Smoluchowski (*4*). The complete derivation of the Helmholtz-Smoluchowski concept may be found in any standard text (*1*, *3*). Very generally speaking, it consists of evaluating the two forces involved in electrokinetic phenomena. The first is the force on a particle in motion caused by viscous friction; the other is the force exerted on a charged particle by an external electric field. From the evaluation of these factors the following equation is obtained for the electrophoretic velocity (u) of a particle:

$$u = \frac{\epsilon\zeta}{4\pi\eta}\,\mathcal{E} \qquad (1)$$

where ϵ is the dielectric constant, ζ is the potential between the particle and all that adheres to it, and the free liquid, η is the viscosity of the liquid, and $\mathcal{E}$ is the potential gradient of the external electric field.

The quantity that was determined experimentally in the present study is the electrophoretic mobility (μ), defined by the following expression:

$$\mu = \frac{u}{\mathcal{E}} = \frac{\epsilon\zeta}{4\pi\eta} \qquad (2)$$

It may be seen that if correct and constant values of the viscosity and dielectric constant are assumed, values of zeta potential are directly proportional to and calculable from the electrophoretic mobility values.

EXPERIMENTAL PROCEDURE

Observations of electrophoretic mobility were made in the apparatus described in the previous paper (*q.v.*), and the same procedure as was employed therein was followed. All samples of rosin-aluminum sulphate complex were agitated for 20 sec. in a mixer of the Waring blendor type.

Foreign electrolyte was added to the water used in

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all steps of the procedure. The purpose of so doing was to duplicate, as far as possible, conditions which might exist in practice should the process water be contaminated. However, some of the electrolytes studied are of academic interest only, there being slight probability that they would ever be found in mill waters.

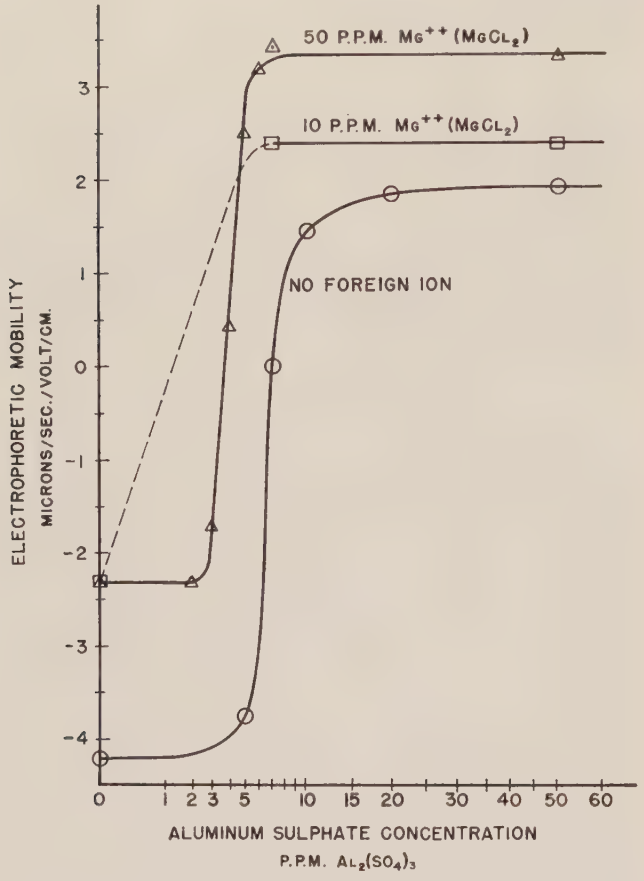

Fig. 1. Variation in electrophoretic mobility of rosin-aluminum sulphate complex with addition of magnesium chloride (40 p.p.m. rosin size)

The effect of foreign ion on the electrophoretic mobility of rosin-aluminum sulphate complex was studied in two ways. In the first type of experiment, a fixed amount of contaminant was added and a series of runs were made with varying concentration of aluminum sulphate. In the second type of experiment, the aluminum sulphate concentration remained constant at 0.005% (as anhydrous salt) while the concentration of foreign ion was varied from run to run. In all experiments the concentration of rosin size was fixed at 0.004% size solids.

RESULTS

Figures 1, 2, and 3 give results of experiments of the first type. In all three cases the lowermost curve is the relation of electrophoretic mobility to aluminum sulphate concentration presented in the previous paper. From Fig. 1 it may be seen that addition of magnesium chloride displaces the curve upward but does not change its essential shape. Addition of aluminum chloride, however, eliminates the S shape entirely, as well as displacing the values of mobility upward. This effect is shown in Fig. 2. Figure 3 demonstrates that addition of magnesium sulphate has no effect on the mobility except at very low aluminum sulphate concentrations.

Experiments of the second type are summarized in Fig. 4. Here values of electrophoretic mobility as ordinates are plotted against molality of foreign cation on linear coordinates. It may be noted that the data for the added foreign sulphates lie lower than those for addition of various chlorides and that a downward trend of mobility of rosin-aluminum sulphate complex with increasing concentration of foreign sulphate is noticeable. This last observation may be compared with the sizing experiment results of Woodberry (*6*), where a downward trend in sizing efficiency with increasing concentration of foreign sulphate was noted.

Further interesting relationships may be observed if the data of the left portion of Fig. 4 are replotted with a logarithmic abscissa scale. The data on foreign chlorides are so plotted in Fig. 5. It may be observed that the results fall roughly into distinct classes according to the valence of the metallic ion. The behavior of

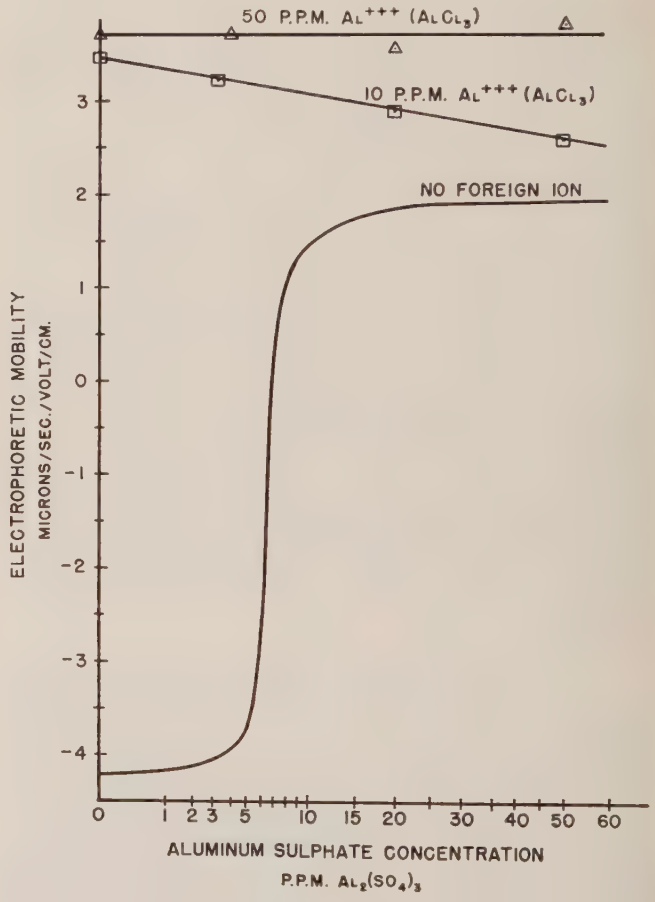

Fig. 2. Variation in mobility with addition of aluminum chloride (40 p.p.m. rosin size)

barium chloride appears anomalous. It should be recalled, however, that the precipitation of barium sulphate which occurs alters the sulphate ion concentration. Thus, the constant amount of divalent anion employed in all other cases is not present in the case of barium chloride addition.

Over a considerable concentration range, mobility

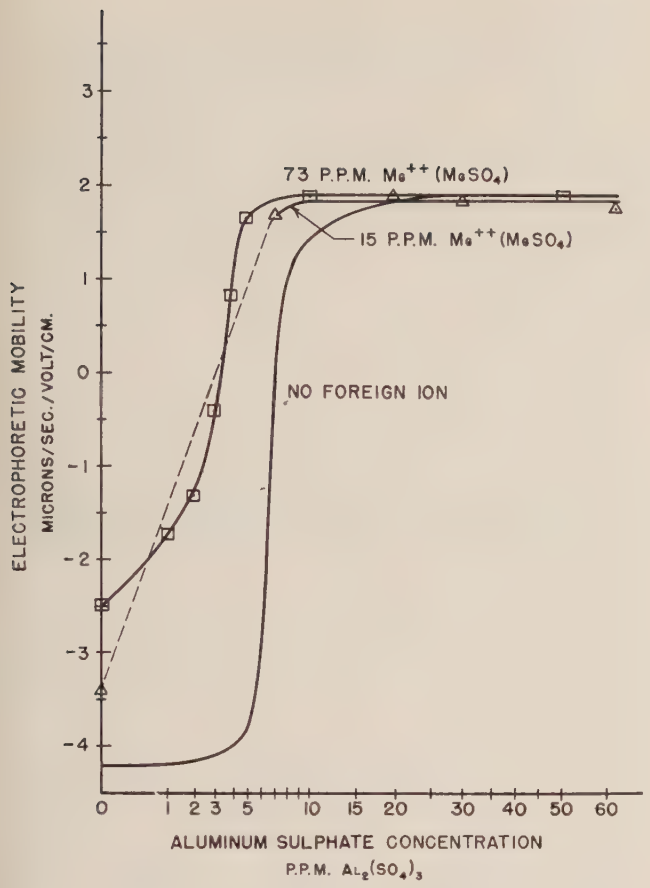

Fig. 3. Influence of magnesium sulphate on mobility data (40 p.p.m. rosin size)

of rosin-aluminum sulphate complex formed in the presence of foreign chlorides may be expressed as a function of the logarithm of foreign cation concentration, the relation being:

$$\mu = k_1 + k_2 \log C \qquad (3)$$

where μ is the electrophoretic mobility in microns per second per volt per centimeter and C is the concentration of foreign cation in gram-mols per 1000 grams of solution. Values of the constants k_1 and k_2 for various salts, as obtained in this study, are given in Table I.

Still more comparisons may be made from the data on

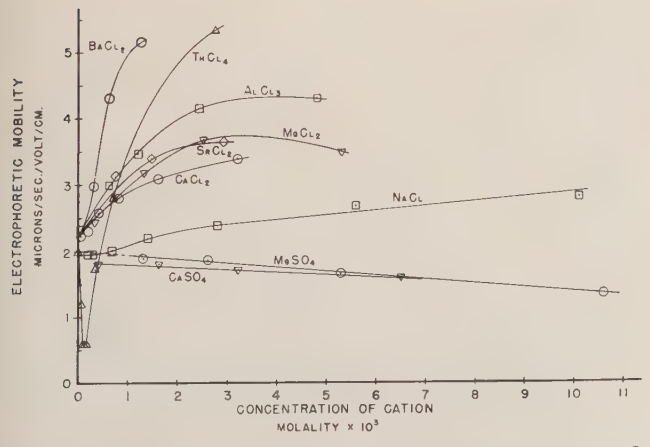

Fig. 4. Electrophoretic mobility of rosin-aluminum sulphate complex as a function of concentration of foreign cation (40 p.p.m. rosin size, 50 p.p.m. aluminum sulphate)

the effect on mobility of the addition of various chlorides and sulphates of divalent metals shown in Fig. 6. The observation noted above regarding the depressing effect of the foreign sulphates may again be made here.

DISCUSSION

Equation (3) may be converted to a differential form in which it appears as:

$$\frac{d\mu}{dC} = \frac{K}{C} \qquad (4)$$

where K is a constant of the system for each different foreign ion involved. It is of interest to note that the

Table I. Constants of Mobility Equation[a]

Cation[b]	k_1	k_2	*Experimental limits, molal*
Na^+	4.09	0.66	$0.0006 < C < 0.001$
Mg^{++}	7.09	1.33	$0.0003 < C < 0.0025$
Ca^{++}	5.59	0.89	$0.0002 < C < 0.004$
Sr^{++}	6.77	1.19	$0.0002 < C < 0.0025$
Ba^{++}[c]	15.2	3.38	$0.0002 < C < 0.0012$
Al^{+++}	7.66	1.43	$0.0002 < C < 0.004$
Th^{++++}	15.4	3.94	$0.0002 < C < 0.003$

[a] Equation (3) in text.
[b] All as chloride salts.
[c] Chemical reaction removes part of the sulphate ion originally present from the aluminum sulphate.

form of these equations empirically derived from the experimental data of this investigation is very similar to that of the theoretical equation for the adsorption of

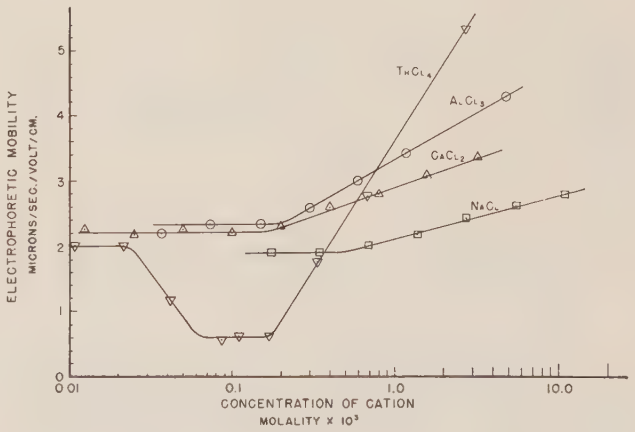

Fig. 5. Mobility-concentration relationships for various chlorides (plotted on semilogarithmic coordinates) (40 p.p.m. rosin size, 50 p.p.m. aluminum sulphate)

ions on colloidal material derived from the Nernst half-cell equation. This derivation, as presented by Weiser (5), follows.

The derivation is that of an equation for the amount of an ion preferentially adsorbed by a colloidal particle suspended in an electrolyte containing the ion. Nernst's equation for the potential of an electrode at equilibrium with one of its ions (half cell) is:

$$E = E_0 - \frac{RT}{NF} \ln \alpha \qquad (5)$$

where R is the gas constant, T is the absolute temperature, F is the electrochemical equivalent, α is the activity of the ion, and E_0 is the standard electrode potential.

If α_0 is the equilibrium activity of the ions at the point in the solution of zero charge, equation (5) becomes:

$$E - E_0 = \frac{RT}{NF} \ln \frac{\alpha_0}{\alpha} \qquad (6)$$

Since the total potential drop due to free charges is $E - E_0$ and is defined as H, then:

$$H = \frac{RT}{NF} \ln \frac{\alpha_0}{\alpha} \qquad (7)$$

For a constant capacity of the double layer, the amount of ion adsorbed per gram of colloid (x/m) is proportional to H, hence:

$$x/m = k_1' + k_2' \log \alpha \qquad (8)$$

in which k_1' and k_2' are constants fixed by the location of the zero point of charge and by the adsorption capacity.

The comparison of this equation and the previously cited

$$\mu = k_1 + k_2 \log C \qquad (3)$$

is striking.

At the concentration involved, the activity of the foreign cation is probably directly proportional to the molality. It is therefore not out of reason to conclude that the variation in electrophoretic mobility observed

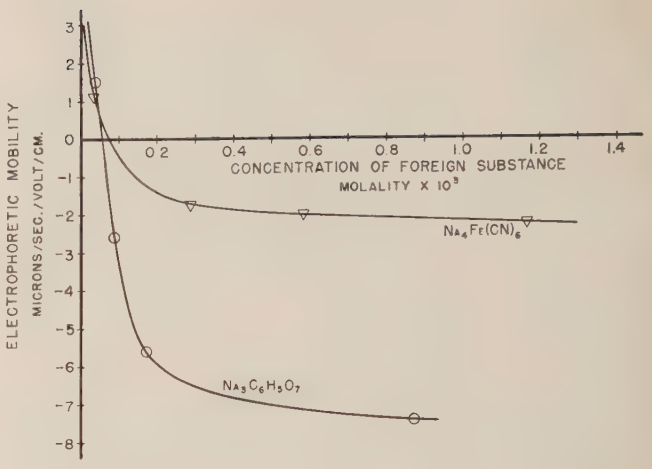

Fig. 7. Effect of sodium citrate and sodium ferrocyanide on the electrophoretic mobility of rosin-aluminum chloride complex (40 p.p.m. rosin size, 39 p.p.m. aluminum chloride)

equation so closely approximates relations based on theoretical concepts.

Relation to Sizing

Experiments have shown that small amounts of certain anions cause a drastic drop in sizing efficiency (*6*).

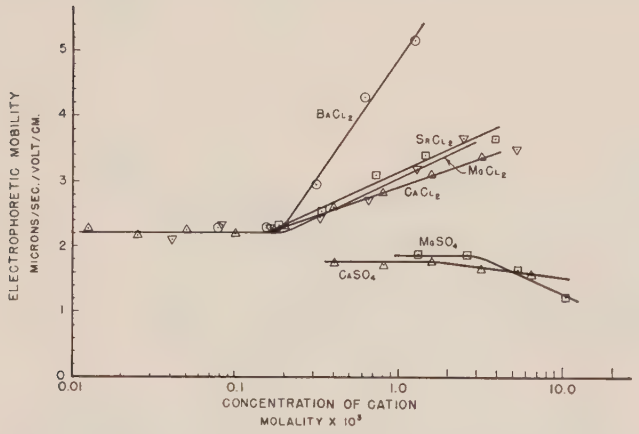

Fig. 6. Mobility-concentration relationships for various salts of divalent metals (plotted on semilogarithmic coordinates) (40 p.p.m. rosin size, 50 p.p.m. aluminum sulphate)

in the range noted in this investigation is caused by the preferential adsorption of the foreign cation on the rosin-alum complex. The mechanism of that adsorption may well be a matter of question. The foreign anion has been found to have a decided effect on the mobility of the complex and it is also conceivable that there may be primary or partial valence forces left on the rosin part of the complex that have not been satisfied by aluminum ion.

Considering the manifold variables involved, the relationships among the various constants k_1, k_2, k_1', and k_2' are not at all clear. It is possible, however, that the various factors involved in the empirical constants k_1 and k_2 may be evaluated when further information becomes available on this system. In the meantime, it is encouraging to note that the experimentally obtained

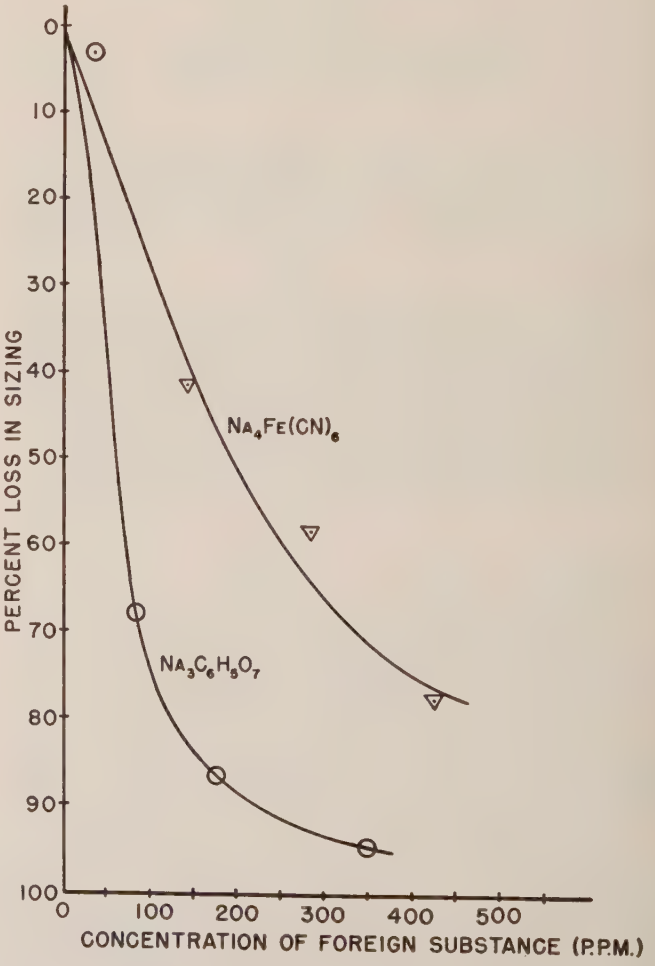

Fig. 8. Influence of sodium citrate and sodium ferrocyanide on sizing efficiency; 2.5% fiber consistency; 0.67% aluminum chloride and 0.75% rosin size based on weight of fiber; pH 4.3 (data of N. T. Woodberry (6))

Accordingly, electrophoretic mobility experiments were run on size precipitate formed in the presence of the citrate ion and the ferrocyanide ion, substances found to affect sizing unfavorably.

As shown in Fig. 7, both of these materials cause a rapid decrease in the mobility of rosin-aluminum chloride complex. As the concentration of either of these materials increases, the electrophoretic mobility rapidly drops to zero and then becomes negative, eventually leveling off at some negative value. At such point the complex will have the same charge as cellulose and would not be expected to size well if the electrostatic theory of sizing (Ostwald-Lorenz theory) is to hold. As may be seen from the data of Woodberry (*6*), this is precisely the situation that holds (see Fig. 8). It may be seen from these data that sizing efficiency drops rapidly with increasing concentration of sodium citrate, somewhat less rapidly with increasing concentration of sodium ferrocyanide. The effect of these two materials is in the same proportion as their effect on mobility.

While it is difficult to establish a quantitative relationship between electrophoretic mobility and sizing efficiency from the above data, there is no doubt that, once again, the qualitative indications are in substantial agreement with the electrostatic theory of sizing.

CONCLUSIONS

As determined by electrophoretic mobility measurements, the net surface potential of rosin-aluminum sulphate complex is decreased by the presence of sulphates. This is thought to be consistent with the electrostatic theory of sizing in that a corresponding decrease in sizing effectiveness in the presence of added sulphates has been observed.

The effect of chlorides up to a limit of about 0.008 molal may be represented by an empirical equation of the form $d\mu/dC = K/C$ or $\mu = k_1 + k_2 \log C$ with values of the constants depending on the salt concerned. A similarity of this function to an equation for ion adsorption derivable from the Nernst half-cell concentration potential theory is observed. It is concluded that the variation in electrophoretic mobility of rosin-aluminum sulphate complex (and therefore in net potential) observed in the range noted with the addition of various chlorides is probably caused by the preferential adsorption of the foreign cation on the rosin-alum complex.

Comparison of electrophoretic mobility data obtained for the addition of sodium citrate and sodium ferrocyanide to rosin-aluminum chloride complex with sizing data obtained with the same systems furnishes further evidence substantiating the electrostatic theory of sizing.

LITERATURE CITED

1. Abramson, H. A., "Electrokinetic Phenomena and Their Application to Biology and Medicine," pages 17 ff, New York, Chemical Catalog Co., 1934.
2. Helmholtz, H., *Wied. Ann.* 7: 337 (1879). Abramson, *op. cit.*, p. 42.
3. McBain, J. W., "Colloid Science," pages 194–197, Boston, B. C. Heath and Co., 1950.
4. Smoluchowski, M., *Krak. Ann.* 182 (1903). Abramson, *op. cit.*, p. 50.
5. Weiser, H. B., "A Textbook of Colloid Chemistry," page 227, New York, John Wiley and Sons, 1949.
6. Woodberry, N. T., Private communication (April, 1952).

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A technical paper in the Maine Technology Experiment Station Series.

A Physicochemical Study of a Water-Soluble Polysaccharide from Douglas-Fir (*Pseudotsuga taxifolia*)

JAMES O. THOMPSON, JOSEPH J. BECHER, and LOUIS E. WISE

A brief study has been made of some molecular properties of a *cold water-soluble* polysaccharide system isolated under mild conditions and in a yield of 0.8% from the heartwood of a 107-yr.-old Douglas-fir. Paper chromatography of the hydrolyzate showed the presence of galactose, arabinose, and xylose, and traces of acidic material; the weight ratio of galactan to araban to xylan was 90:9:1. The aqueous solution had a pH of 7, $[\alpha]_D + 19°$, and an intrinsic viscosity, $[\eta]$, of 0.28. Osmotic pressure measurements on the aqueous solution indicated a number average degree of polymerization (DP_n) of 340; similar measurements on an acetate (degree of substitution about 2) in methyl ethyl ketone indicated a DP_n of 425. Osmotic pressure measurements in methyl Cellosolve, dioxane, and chloroform indicated molecular association in these solvents. Viscosity studies suggested that the polysaccharide is less highly branched than is the arabogalactan of larch. Chain degradation was shown to occur slowly in aqueous solution at 30°C. in the presence of air, and rapidly at 100°C. in the presence of air or in an atmosphere of nitrogen. *Hot-water treatment* of the fibrous residue which remained after the cold-water extraction was shown to remove appreciable amounts of carbohydrate material including units of glucose and mannose in addition to those of galactose, arabinose, and xylose. The pH of the extract was about 3; it was considered probable that acid hydrolysis of cell wall components had occurred. The dangers attending a hot-water "extraction" are discussed briefly.

"Among the cold water-soluble components of a number of coniferous woods, especially the larches, are polysaccharides which have been termed arabogalactans, inasmuch as their hydrolysis products are almost

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exclusively arabinose and galactose" (*1*). The arabogalactan from larch (*Larix occidentalis, et al.*), which may be obtained in yields of over 15%, has been studied extensively (*2–8*). Rather similar polysaccharide fractions have been obtained, though in much smaller yields, from long-leaf pine (*Pinus palustris*) (*9*), black spruce (*Picea mariana*) (*10*), jack pine (*Pinus banksiana*) (*11*), Douglas-fir (*Pseudotsuga taxifolia*) (*12, 13*), and Jeffrey pine (*Pinus jeffreyi*) (*14*). Only very limited studies have been made of these latter systems. In view of the data obtained by Peterson, Barry, Unkauf, and Wise (*4*), Mosimann and Svedberg (*6*), and Campbell, Hirst, and Jones (*8*), it is deemed advisable to regard the arabogalactans not as homogeneous polysaccharides but rather as systems containing two or more related components.

In 1945 Anderson (*12*) extracted Douglas-fir wood with hot water and isolated a mixture of polysaccharides. Two successive extractions were made by heating the wood for 6 hr. with 10 parts of water in a *boiling-water bath.* The resulting extract was concentrated *in vacuo* and then precipitated with a large excess of alcohol. Anderson has described the (incomplete) separation of pectic substances from this mixture. According to his analytical data, the residual carbohydrates appeared to be a mixture of a mannan and an arabogalactan which defied complete fractionation. The presence of the corresponding sugar units was shown by the preparation of appropriate derivatives. D-Galactose was isolated as the free crystalline sugar, and was also identified by conversion into mucic acid. D-Mannose was identified by conversion into the phenylhydrazone (m. 195°). L-Arabinose was isolated as the α-benzyl phenylhydrazone, m. 173–174° ($[\alpha]_D$ − 10.5°), the mother liquor from which yielded mannose α-benzyl phenylhydrazone m. 163–164°.

Subsequently, Graham and Kurth (*13*) noted that the cold-water extract of Douglas-fir wood gave a carbohydrate containing galactose and pentose sugar units.

The present paper describes a brief study made on the cold water-soluble polysaccharide which was extracted from the heartwood of a 107-yr.-old Douglas-fir. It was considered of particular interest to determine the number-average degree of polymerization, (DP_n), and the dilute solution viscosity behavior of this polysaccharide system and thus provide a basis for comparison with the data of Husemann (*5*) and Mosimann and Svedberg (*6*) for the arabogalactan of larch. The osmotic pressure data of Husemann indicated a DP_n of about 220 [number-average molecular weight (M_n), 35,000]; and the low intrinsic viscosity observed indicated a high degree of branching. Mosimann and Svedberg, on the basis of diffusion and sedimentation velocity experiments, concluded that the system consisted of two components, one having a molecular weight of 16,000 and the other a molecular weight of 100,000. They calculated from their data a value for M_n of 49,000 (DP_n = 310).

PREPARATION AND PROPERTIES OF THE POLYSACCHARIDE

Douglas-fir sawdust (30 to 80 mesh, prepared from the central portion of the butt log of a tree having 107 rings) was extracted several times at room temperature with 50% aqueous alcohol and then filtered on a Buchner funnel. The moist meal was then extracted with oxygen-free distilled water under an atmosphere of nitrogen for 1 hr. at room temperature (2 ml. of water per gram of oven-dry wood), filtered, and the water extract poured into 4 volumes of ethanol, whereupon the polysaccharide separated as a white flocculent precipitate. This was separated by centrifuging, redissolved in oxygen-free water, filtered through paper, reprecipitated with 4 volumes of ethanol, and again separated by centrifuging. After washing several times with ethanol and absolute ether and drying under reduced pressure at room temperature, the polysaccharide was recovered as a nearly white fluffy powder in a yield of of 0.8% (based on the oven-dry weight of the wood). Similar experiments with sawdust from the sapwood of this same tree and from both the sap and heartwoods of a younger tree (30 annual rings) yielded only traces of polysaccharide. A subsequent experiment with sawdust from the heartwood of the older tree showed that a white product of similar properties and in similar yield could be obtained without previously extracting the sawdust with 50% ethanol. Graham and Kurth (*13*), who also studied Douglas-fir extractives, concentrated their aqueous extract *in vacuo* prior to the precipitation in alcohol and obtained a yield of 0.89%. In the present work it was desired to isolate the polysaccharide with the minimum possible degradation and, hence, concentration of the aqueous extract was avoided. Further, the use of an electrolyte to assist in the separation of the polysaccharide upon addition to alcohol was avoided in order that the ash content of the isolated product would not be influenced by sorption of added electrolyte.

The polysaccharide was readily soluble in cold water and in formamide without swelling to give clear solutions. A 2% solution in water had a pH of 7.0 and $[\alpha]_D^{23}$ + 19°. The sulphated ash was 0.44% and the araban content (from furfural determination) was 8.9%. Paper chromatography of the hydrolyzate obtained by heating the polysaccharide with sulphurous acid at 135°C. for 90 min. indicated a marked preponderance of galactose, a lesser amount of arabinose, a small amount of xylose, and a trace of acidic material. A very faint spot corresponding to mannose was observed when the amount of hydrolyzate spotted on the paper was much larger than that normally used. Quantitative analysis of the hydrolyzate by the paper chromatographic method, in which the sugars are oxidized with sodium periodate and the formic acid titrated with alkali (*15*), indicated that the ratio of galactan to araban to xylan was 90:9:1 by weight.

ACETYLATION

Viscosity and osmotic pressure measurements made on aqueous solutions are often complicated because of electric and other effects; this is especially so when the polymer is a polyelectrolyte—i.e., when it has ionizable groups along the polymer chain (*16*). In order to provide a check on such measurements it is desirable to perform corresponding measurements in nonaqueous media and this usually necessitates the preparation of a derivative such as the acetate. The derivative must, of course, be prepared in such a way as to avoid degradation of the polymer molecule. Husemann (*5*) has shown that the arabogalactan of larch can be acetylated

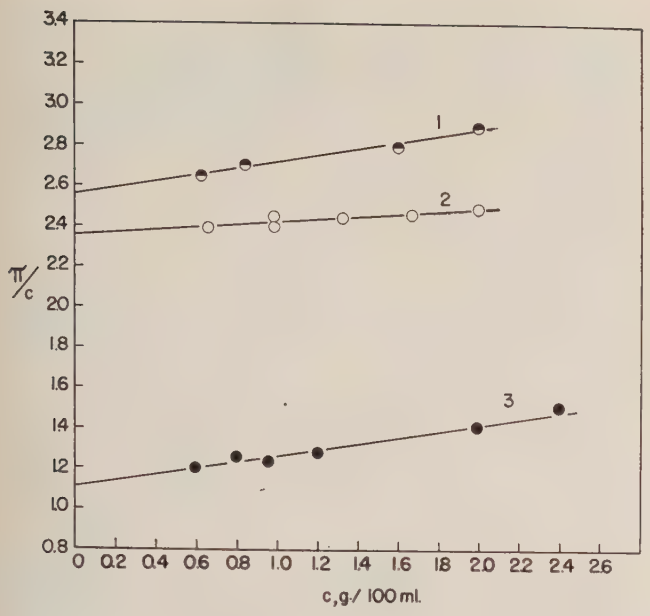

Fig. 1. Osmotic pressure of the acetate in three different solvents at 30°C.
1—methyl ethyl ketone; 2—acetone; 3—chloroform.

without appreciable degradation at 20°C. but that, at 60°C., degradation of the polymer occurs. The method of acetylation employed in the present work was similar to that of Husemann, except that a lower temperature was used. Three grams of the polysaccharide were dissolved in 75 ml. of pyridine to which had been added 10 ml. of water and the solution was cooled to about 5°C.; 75 ml. of cold acetic anhydride were then added and the temperature was maintained below 20°C. The reaction mixture was kept in a refrigerator at 3°C. for 3 days. The acetate was recovered from solution by pouring the latter into a 50:50 mixture of ether and petroleum ether and centrifuging. The product was redissolved in chloroform, filtered, and the clear solution poured into a mixture of ether and petroleum ether. The white solid obtained by centrifuging was washed several times with low boiling petroleum ether and dried under reduced pressure at room temperature.

The yield obtained was 3.8 grams and the acetyl content, as determined by the method of Genung and Mallatt (*17*), was 32.5% indicating a degree of substitution of about 2. The acetate was readily soluble in acetone, methyl ethyl ketone, chloroform, dioxane, and methyl Cellosolve; $[\alpha]_D^{28}$ of 2% solutions in these solvents were (approximately) −9.5, −12, −23, −17, and −14°, respectively.

OSMOTIC PRESSURE STUDIES

Osmotic pressure measurements were made on the acetate in a number of different solvents with glass osmometers of the Zimm and Myerson design (*19*). Membranes were prepared from Du Pont 600 PT non-waterproofed cellophane by swelling in aqueous sodium hydroxide at room temperature for 1 hr. as follows: 15% sodium hydroxide for acetone, methyl ethyl ketone, and methyl Cellosolve, and 25% sodium hydroxide for chloroform and dioxane. The half-lives of the two series of osmometers with acetone and chloroform were 70 and 50 min., respectively. The semistatic method of measurement was employed and the concentrations of the solutions in the osmometers were checked at the end of each measurement by taking dry weights *in vacuo* at 100°C.

The initial measurements were made with acetone and chloroform solutions; it was found that the apparent number average molecular weight (M_n) in chloroform was more than twice that observed in acetone. A third series of measurements was then made with methyl ethyl ketone; the results obtained were close to those found in acetone. The plots of π/c versus c for these three solvents are shown in Fig. 1. Additional measurements were made at two different concentrations in dioxane and methyl Cellosolve; in both solvents the estimated M_n was of about the same magnitude as that calculated from the chloroform data—i.e., about twice that observed in acetone and methyl ethyl ketone. The data are summarized in Table I.

The explanation for this variation of apparent molecular weight with solvent appears to be that the polymer molecules are associated to varying extents in the different solvents. The association probably results from secondary bonds between the polymer molecules—possibly between acetyl groups and uncovered hydroxyl groups. Molecular association of this type has been observed with cellulose acetate in methyl Cellosolve and with polyvinyl chloride in dioxane and methyl ethyl ketone solutions and has been discussed by Doty, Wagner, and Singer (*20*). If the assumption is made that the acetate is essentially unassociated in methyl ethyl ketone, the number-average molecular weight calculated for the polysaccharide is about 67,000, which corresponds to a DP_n of 425.

Osmotic pressure measurements were made on aqueous solutions of the polysaccharide to provide a rough check on the measurements made with the acetate. The osmometers used were of the simple Adair design with thimble-type cellulose nitrate* membranes prepared according to the method of Alexander and Johnson (*21*). Toluene was used in the measuring capillary and the semistatic method of measurement was made possible by the use of a hypodermic syringe fitted with a fine stainless steel capillary to adjust the liquid height in the capillary. The plot of π/c versus c for this system is shown in Fig. 2. The number-average molecular weight calculated from these data is 53,000

* The cellulose nitrate used was kindly donated by the Burnside Laboratory of E. I. du Pont de Nemours and Co. (Inc.) and was designated as Type HA 17 W (19.4 sec.).

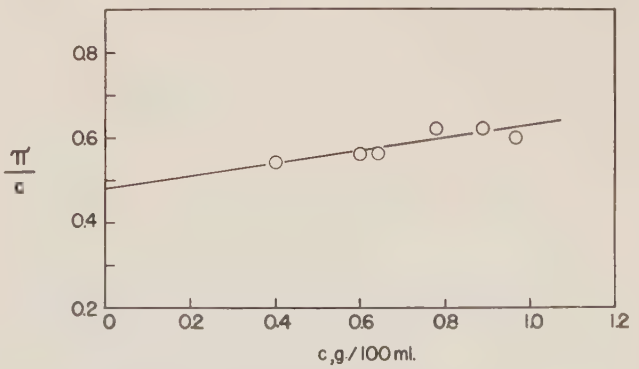

Fig. 2. Osmotic pressure of the polysaccharide in water 30°C.

(DP_n = 340). That this value for the DP_n is lower than that observed with the acetate in acetone or methyl ethyl ketone suggests that trace amounts of the acidic material observed on the paper chromatogram are actually present as ionizable groups (probably uronic acid) on the polymer chains. These, of course, would be expected to interfere in water solution and reduce the DP_n of the polymeric system.

Table I. Apparent Number-Average Molecular Weights of the Acetate

Solvent	*Molecular weight*
Methyl ethyl ketone	100,000
Acetone	110,000
Methyl Cellosolve	170,000[a]
Dioxane	200,000[a]
Chloroform	230,000

[a] Estimated from osmotic measurements at two concentrations.

VISCOSITY STUDIES

Viscosity measurements were made on dilute solutions of the polysaccharide and its acetate with capillary viscometers of the Ostwald-Fenske type which had flow times for water of about 200 sec. at 30°C. Intrinsic viscosities, $[\eta]$, were determined in the usual way by plotting the reduced specific viscosity ($\eta_{sp.}/c$) against concentration (c) (in grams per 100 ml.), and extrapolating to zero concentration. Typical straight line plots were obtained for all systems examined. The plot for the polysaccharide in water is shown in Fig. 3 from which the intrinsic viscosity is seen to be 0.28. This value is about four times that found by Husemann (*5*) (and confirmed in this laboratory) for the arabogalactan of larch in water solution. Intrinsic viscosities in 0.05 *N* NaCl and in 10% potassium hydroxide were found to be 0.25 and 0.07, respectively.

It is interesting to note that the intrinsic viscosity in water is four times that in 10% potassium hydroxide for the polysaccharide from Douglas-fir whereas, in the case of larch arabogalactan, the viscosities in water and in 6% sodium hydroxide are essentially equal (*5*). The difference in viscosity of the Douglas-fir polysaccharide in the two solvents may be caused by some electric or other complicating effect, but it seems equally possible that this difference may result from an ability of the

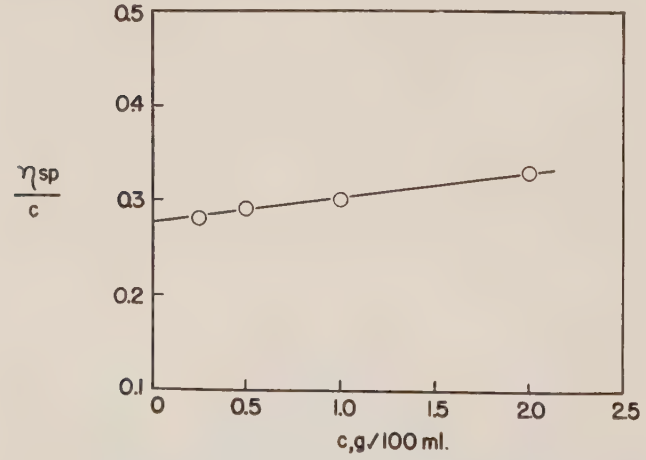

Fig. 3. Plot of viscosity against concentration for the polysaccharide in water at 30°C.

Fig. 4. Paper chromatograms; I, reference mixture of known sugars; II, hydrolyzate of cold-water extract; III, hydrolyzate of hot-water extract: IV, hydrolyzate of representative hemicellulose fraction.

polysaccharide molecules to respond to differences in solvent nature by assuming, on the average, a more or less open or extended configuration in good solvents and a more or less closed or compact configuration in poor solvents (*18*). If, for example, water is a better solvent than 10% aqueous potassium hydroxide, then the polymer molecules would assume a more extended configuration in water than in caustic solution and, as a result, would have a higher intrinsic viscosity in the former than in the latter. The fact that the arabogalactan of larch does not show this same type of viscosity behavior suggests that its molecules are less able to respond in this manner to differences in solvent nature. A number of different factors may be playing a part here, such as molecular size, molecular size distribution, molecular association, and solvation; but the most probable explanation seems to lie in the interesting possibility that the polymer molecules of the larch arabogalactan are more highly branched than are those of the Douglas-fir polysaccharide. The more highly branched molecules would not be expected to respond to solvent differences to the same extent as would the less highly branched molecules—other things being equal. It has been tacitly assumed in this discussion that the polymer molecules of the two systems are significantly and equally flexible. However, there is insufficient experimental evidence to justify this assumption. If the molecules of the western larch arabogalactan are actually relatively rigid, this alone would prohibit configurational response to solvent differences.

The intrinsic viscosities of the acetate in several solvents are shown in Table II. The values in acetone and chloroform are 0.25 and 0.22, respectively, whereas the corresponding values observed by Husemann (*5*) for an acetate of larch having essentially the same degree of substitution are 0.06 and 0.05. Difference in

the average-molecular size of the two polymer systems may be responsible for the observed differences in viscosities but it seems probable that the degree of branching is also an important factor.

Table II. Intrinsic Viscosities of the Acetate at 30°C.

Solvent	*Intrinsic viscosity*
Acetone	0.24
Methyl ethyl ketone	0.27
Chloroform	0.21
Dioxane	0.33
Methyl Cellosolve	0.18

In connection with the intrinsic viscosity data of Table II, it should be noted that the lowest value is that for methyl Cellosolve. This suggests that methyl Cellosolve is a poor solvent—i.e., the acetate molecules assume a more compact configuration when in this solvent than when in the other solvents. This is in accord with the observation that the rate of solution of the acetate in methyl Cellosolve was markedly slower than it was in the other solvents. On the basis of the data of Table II, dioxane would be regarded as the best solvent since the higher intrinsic viscosity corresponds to a more extended configuration of the polymer molecules in solution. This discussion has not taken into account any possible influence on viscosity of molecular association in solution. In this connection, however, it may be stated that the work of Doty, Wagner, and Singer (*20*) with polyvinyl chloride in dioxane showed that intrinsic viscosity was not appreciably influenced by differences in degree of molecular association.

DEGRADATION OF THE POLYSACCHARIDE IN SOLUTION

Experiments were performed on aqueous solutions of the polysaccharide to determine whether exposure to air at room temperature or heating at 100°C. would cause appreciable chain degradation as indicated by a decrease in intrinsic viscosity. Exposure to air at 30°C. for 18 hr. caused the intrinsic viscosity to drop from 0.28 to 0.24. Heating at 100°C. for 1 hr. in the presence of air or in an atmosphere of nitrogen caused the viscosity to drop to essentially the same value in both cases—viz., 0.16. Thus it is evident that, although degradation does occur at room temperature, the rate of this degradation as indicated by the viscosity measurements, is slow as compared with the rate when the solution is heated at 100°C. These data indicate clearly that, if the polysaccharide is to be isolated from the wood with the minimum of degradation, *the isolation must be carried out as rapidly as possible and without heating.*

HOT-WATER EXTRACTION

In view of the fact that mannose residues were detected in appreciable amounts in the hot-water extract of Anderson (*12*) but were virtually absent in the cold-water extract of the present study, it was considered of interest to apply the technique of paper chromatography to the hydrolyzate of a *hot-water extract.* Accordingly, the fibrous residue which remained after two cold-water extractions, was subjected to the hot-water treatment described by Anderson. The pH of the extract was about 3 (in contrast to pH 7 of the cold-water extract). When this hot-water extract was hydrolyzed—either with sulphurous or sulphuric acid—and the constituent sugars separated by means of paper chromatography, it was found that, in addition to galactose, arabinose, and xylose the sugars, mannose and glucose, were present in appreciable amounts. A photograph of the chromatograms obtained in this study is shown in Fig. 4. Column I shows the spots obtained with a synthetic reference mixture of the five sugars: galactose, glucose, mannose, arabinose, and xylose. Column II shows the spots for galactose, arabinose, and xylose obtained with the hydrolyzate of the cold-water extract (the faint trace of mannose produced a spot too weak to show in the photograph). Column III shows the spots obtained with the hydrolyzate of the hot-water extract. It will be noted that in this column the galactose and arabinose spots are somewhat darker than those for the other sugars. This suggests the presence of arabogalactan in the hot-water extract which probably resulted from incomplete removal from the wood during the cold-water extraction. Column IV shows the chromatogram obtained with the hydrolyzate of a representative *hemicellulose fraction* prepared from a portion of the same sample of wood which had previously been thoroughly extracted with cold water. Thus we have some evidence that the hot-water treatment produces more than mere removal of substances extraneous to the cell wall. There appears to be a strong possibility that acid hydrolysis of cell wall components may also occur. Recently such a possibility was suggested by Green and Leaf (*22*). When these investigators extracted unseasoned jack pine wood with *cold water*, approximately 1% of the wood was removed. Subsequent extractions with *cold* water changed this value very little. On the other hand, when this same pine wood was "extracted" successively by refluxing with boiling water, wood components were removed at a fairly constant rate for about 60 hr. and more slowly thereafter. These extracts were strongly acidic and nearly 18% of the weight of the wood was lost. This hot-water extract contained nearly 11.5% of carbohydrate material based on the dry weight of the wood. A portion of this extractive was a polysaccharidic system, which on analysis showed a molar ratio of galactose:arabinose:uronic anhydride of 9:2:1. Browning, (*23*) has also pointed out that protracted hot-water extraction may cause gradual hydrolysis of wood. The dangers attending a hot-water extraction have been emphasized because this technique may obscure the true nature of the water-soluble extraneous materials, and also because it may result in serious physicochemical changes that would cause misinterpretation of subsequent determinations.

LITERATURE CITED

1. Wise, L. E., *in* Wise and Jahn, "Wood Chemistry," 2nd ed., vol. I, page 644, New York, Reinhold Publ. Corp., 1952.
2. Schorger, A. W., and Smith, D. F., *Ind. Eng. Chem.* 8: 494–499 (1916).
3. Wise, L. E., and Peterson, F. C., *Ind. Eng. Chem.* 22: 362–365 (1930).
4. Peterson, F. C., Barry, A. J., Unkauf, H., and Wise, L. E., *J. Am. Chem. Soc.* 62: 2361–2365 (1940).
5. Husemann, E., *J. prakt. Chem.* 155: 13–64 (1940).

6. Mosimann, H., and Svedberg, T., *Kolloid-Z.* 100: 99–105 (1942).
7. White, E. V., *J. Am. Chem. Soc.* 63: 2871–2875 (1941); 64: 302, 1507, 2838 (1942).
8. Campbell, W. G., Hirst, E. L., and Jones, J. K. N., *J. Chem. Soc.* 1948: 774–777.
9. Foreman, E. L., and Englis, D. T., *Ind. Eng. Chem.* 23: 415–416 (1931).
10. Brauns, F. E., *Science* 102: 155 (1945).
11. Green, J. W., and Wise, L. E., unpublished data of The Institute of Paper Chemistry.
12. Anderson, E., unpublished data of The Institute of Paper Chemistry.
13. Graham, H. M., and Kurth, E. F., *Ind. Eng. Chem.* 41: 409–414 (1949).
14. Wadman, W. H., Anderson, A. B., and Hassid, W. Z., The structure of a polysaccharide from Jeffrey pine. Paper presented at the Symposium on Hemicelluloses and Plant Gums, 123rd meeting of the American Chemical Society, Los Angeles, Calif., March, 1953.
15. Hirst, E. L., and Jones, J. K. N., *J. Chem. Soc.* 1949: 1659. See also Leech, H. J., Doctoral Thesis, The Institute of Paper Chemistry, 1952.
16. Thompson, J. O., and Wise, L. E., *Tappi* 35: 331–336 (1952).
17. Genung, L. B., and Mallatt, R. C., *Ind. Eng. Chem., Anal Ed.* 13: 369–374 (1941).
18. Alfrey, T., *J. Colloid Sci.* 2: 99–114 (1947).
19. Zimm, B. H., and Myerson, I., *J. Am. Chem. Soc.* 68: 911–913 (1946).
20. Doty, P., Wagner, H., and Singer, S., *J. Phys. Colloid Chem.* 51: 32–57 (1947).
21. Alexander, A. E., and Johnson, P., "Colloid Science," vol. 1, page 160, and vol. 2, Appendix II, Oxford, Clarendon Press, 1949.
22. Green, J. W., and Leaf, R. L., *Tappi* 35: 468–480 (1952).
23. Browning, B. L., *in* Wise and Jahn, "Wood Chemistry," 2nd ed., vol. II, page 1135, New York, Reinhold Publ. Corp., 1952.

Received April 16, 1953. Presented at the Symposium on Hemicelluloses and Plant Gums, 123rd Meeting of the American Chemical Society, Los Angeles, Calif., March, 1953.

Packaged Steam Generators in the Paper Industry

F. X. GILG

A "packaged steam generator" is a standardized, shop-assembled boiler, equipped and shipped complete with fuel-burning equipment, mechanical draft equipment, automatic combustion controls with fuel and low-water cutouts, and other accessories. There are "fire-tube" types and "water-tube" types. This paper describes a water-tube type and shows that it really is an extension of the integral-furnace series, in which boiler and water-cooled furnace are designed as an integral unit, with over-all dimensions of length, width, and height limited to meet common-carrier (rail and truck) specifications on weight and clearances. For sizes to generate up to 28,000 lb. of steam per hr. and moderate pressures to 250 p.s.i., packaged steam generators are being used more and more in the paper industry because low fuel costs, low maintenance and operating costs, compactness, portability, simplicity, reliability, and safety in operation are necessities in this progressive industry. Typical examples with pictures of modern installations in paper mills are described with their salient features, operating data, and fuel costs. Automatic combustion control systems are described to show the emphasis given to safety and simplicity in operation.

A "packaged steam generator" is a standardized, shop-assembled boiler, equipped and shipped complete with fuel-burning equipment, mechanical-draft equipment, automatic combustion controls, safety fuel and low-water cutouts, and other accessories. They are quickly and easily installed because they are delivered as a completed unit by rail or truck, ready to skid or lift into position, requiring only a few simple connections to make them ready for service. Since the packages are quite large, taking up most of a truck or railroad car, and never wrapped, "packaged steam generators" does not seem like the proper description of this product. It is preferred to term them as "shop-assembled steam generators."

There are "fire-tube" types in the smaller sizes which are made by several manufacturers in this field. In this design combustion takes place in a large horizontal central furnace tube, the products of combustion then passing through many smaller tubes surrounded by boiler water under pressure, and all contained within a large, cylindrical shell.

There are "water-tube" types in the larger sizes where the greater inherent safety of small tubes under internal boiler pressure is desirable for exposure in the furnace. These are made by several manufacturers who also make the large water-tube boilers and steam generators. The "water tube" type generally consists of an upper and lower drum with small tubes between them, bent to form the furnace and boiler water-cooled walls, and boiler heat-absorbing surface. The shop-assembled water-tube boilers, as manufactured by The Babcock & Wilcox Co. and referred to as the type FM integral furnace boiler, are discussed in this paper.

DEVELOPMENT HISTORY

The development of the integral-furnace type of boiler in which water-cooled furnace and boiler walls become an integral part of the steam-generating unit, as contrasted with the addition of water-cooled walls to existing types of boiler, resulted in a widespread acceptance of this type of steam-generating unit. It provided advantages in easier application to existing buildings, low head-room, small floor space, easier operation and accessibility from the boiler-room floor, low maintenance, high efficiency, and adaptability to more than one fuel with good economy on each fuel. These advantages were quickly realized and resulted in the extension of available sizes of boilers to cover a range of 7500 to 300,000 lb. of steam per hr.

Early in World War II, there developed a need for portable power plants consisting of boilers, auxiliaries, and electric generating equipment, completely shop-assembled on railroad cars, which could quickly be moved to areas where they were needed, requiring only a few connections to make them ready for service.

The first integral furnace boilers, built in 1933, were

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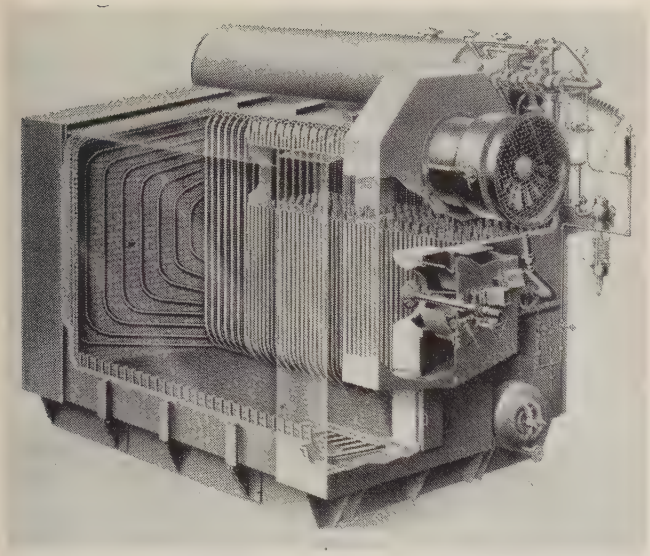

Fig. 1. FM shop assembled boiler

designed so that they could be assembled in the shops and shipped as complete units. This experience was utilized to the fullest extent in designing the wartime applications. Fortunately, from a manufacturing standpoint, there were many boilers of the same type and size which permitted the development of assembly-line techniques for assembling these boilers in the shops. The advantages of having several erection stations manned by crews of workmen who had specific parts to install on these units resulted in considerable saving in erection time with correspondingly lower erection costs, savings that could not be approached with field erection.

In recent years there has been a considerable demand for completely shop-assembled water-tube boilers in industrial power and process plants. The paper industry was quick to recognize the advantages of economical steam generation that can be obtained from these units. They have been used to provide additional steam for increased production of paper and paper products or as a means of reducing steam costs quickly by replacing older, less economical units with one or more of the shop-assembled units.

DESCRIPTION OF FM BOILER

Figure 1 shows a type FM water-tube boiler with completely water-cooled furnace and boiler walls. It has the benefits of compactness, portability, simplicity, reliability, and safety.

The FM boiler is simple in operation—has push-button start and stop, and automatic combustion control for handling variations in load. It is therefore ideal for plants in which operators must attend to other duties while occasionally casting one eye on the water gage glass, steam gage, and burner on the boiler and on the pressure and other instruments on the control panel.

The type FM boiler is designed to provide all-important continuity of service. Its water-cooled furnace, designed in accordance with 25 years' experience in the application of water-cooling to other types of water-tube boilers, makes possible the virtual elimination of maintenance. The proved arrangement of furnace and boiler heating surface assures economical fuel consumption as well as dependable steam service. As in large central-station boilers, the considerable water-cooled surface in the division wall increases the effectiveness of the water-cooled furnace without increasing its volume or its outside space requirements. Furthermore, most advantageous use of heat absorbing surfaces is realized because the combustion gases flow horizontally across the boiler bank in five passes. This method of cross-flow permits the most advantageous use of convection heat-absorption surfaces and is, therefore, another factor contributing to high steam-generating capacity within small space. Old boilers can usually be replaced with a type FM boiler and additional steam capacity is thereby provided at the same time without using additional space.

The amount of water-cooling in the furnace of the type FM boiler is ample to absorb enough heat to cool the furnace gases effectively and to protect the refractory against the destructive effects of slag-forming oils even under overload conditions.

The amount of exposed refractory in the front wall is sufficient to maintain furnace temperature and insure stable ignition and operation under low-load conditions. Years of maintenance-free steam-generating service are secured as well as efficient and dependable year-round performance.

The entire boiler and furnace is enclosed in a rigid steel casing designed properly to permit expansion and contraction of the various components due to temperature changes. It is resistant to the elements and therefore can be installed outdoors. The casing joints are welded for strength and tightness, and, as in the most modern central-station boilers, the casing is buck-stayed to permit the unit to be operated continuously

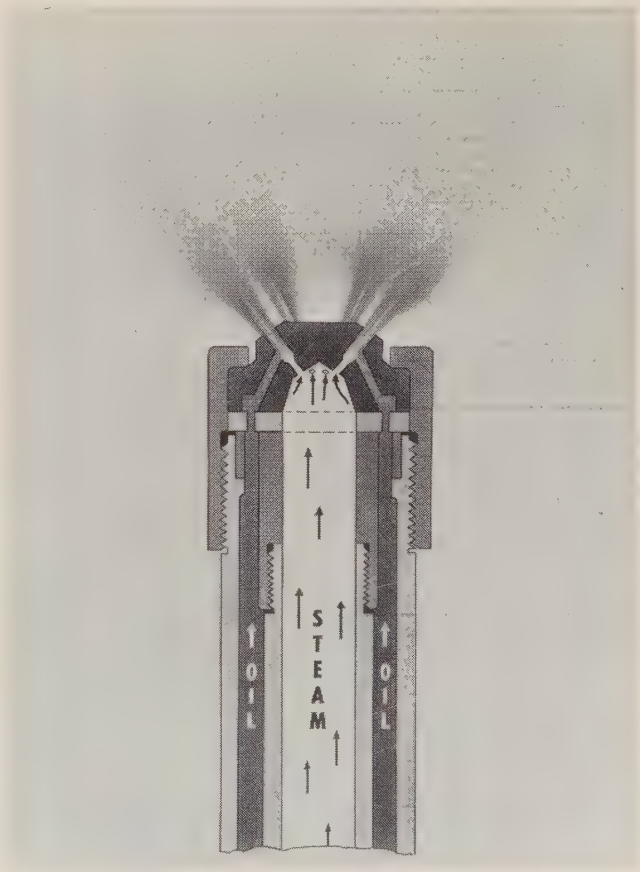

Fig. 2. Y-jet oil atomizer

under pressure from the forced-draft fan, thus eliminating the need for an induced-draft fan or high stacks.

Since no draft is required in a furnace that is operated under sufficient pressure from the forced-draft fan to force the products of combustion through the boiler and out into the stack, additional steam generating capacity can be provided by an FM boiler connected to an existing stack which would not have had the capacity to draft another conventional boiler operating under suction.

For oil firing, units in the smaller capacity range can be equipped with either rotary-cup or steam atomizing Y-jet burners. The larger capacity units are equipped with Y-jet steam atomizing burners as shown in Fig. 2. The several steam jets sweep across the oil jets in the sprayer plate, resulting in complete atomization of the oil which is so necessary for complete combustion and fuel economy. Sprayer plates for mechanical atomization can be used in Y-jet oil burners for starting up when steam for atomization is not available. All units may be equipped with ring-type burners for gas firing as shown in Fig. 3.

By equipping a unit with combination burners, changeover from one fuel to another is easily made. In the event of price variations, advantage can easily be taken of the more favorably priced fuel.

The entire control system including control equipment, gages, valves, and oil pumping and heating set, when desired, is housed in a shop assembled cabinet which requires only a few field connections to the boiler and plant service lines. When desired, a steam-flow meter, an air-flow recorder, and flue-gas temperature recorder may be mounted on the standard panel in the shop.

In operation, the type FM boiler is simply controlled by push-button from the control panel with equipment suited to the requirements of individual installations.

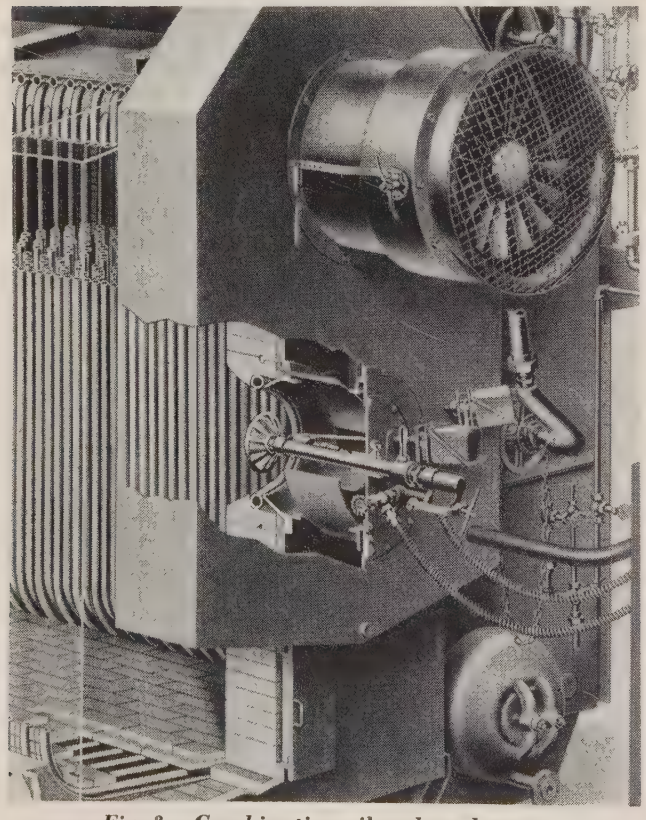

Fig. 3. Combination oil and gas burner

Fig. 4. Boiler being lifted into position

The combustion control is actuated by steam pressure and is usually provided with a fuel-air ratio controller for maintaining the proper ratio of fuel and combustion air at all boiler loads. This type of control is easily adjusted to give the proper response rate for any plant load condition. A full complement of safety interlock equipment is available and is recommended for most conditions.

The safety interlock equipment will automatically shut the boiler down if: (1) burner flame fails, (2) forced-draft fan fails, (3) level of water in boiler drum is too low, (4) oil pump motor fails (oil burning only), (5) gas pressure is too low (for ignition or gas burning), or (6) oil temperature is too low (oil burning only).

When the boiler load is below 25%, the control system is arranged so that burner will operate on a start-stop schedule. When the boiler load is above 25%, the control system will operate the burner continuously, regulating fuel and combustion air to suit the load demand.

Easy cleaning of type FM boilers is effected through the use of a single soot blower extending entirely across the boiler passes. The soot blower is operated by means of a hand wheel readily accessible from the operating floor.

Access to furnace for inspection of the interior is had through a conveniently located opening in the front wall of the furnace. Access to the boiler tube bank for inspection is had through removable plates on the casing.

As shown in Figs. 4 and 5 it is easy to install since it is delivered as a unit, ready to skid or lift into position, hook up, and place in operation. It can be set on a

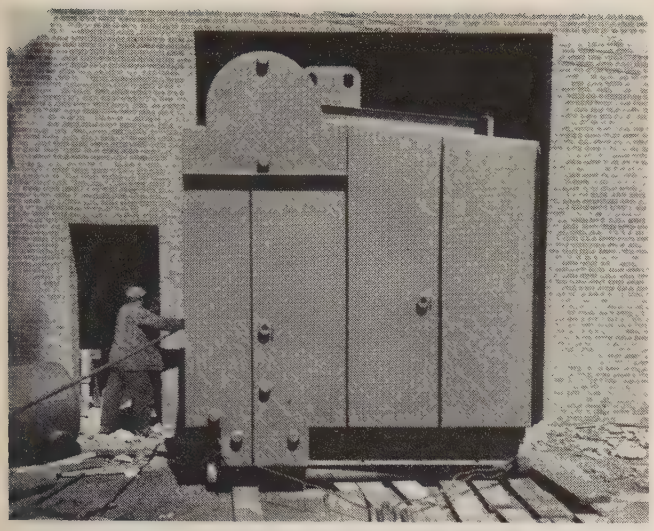

Fig. 5. Boiler being moved into building

Fig. 7. Boiler on railroad car

concrete floor or simple foundation thereby saving in cost of building and installation.

Space in the shop is devoted exclusively to assembly of type FM boilers as shown by Fig. 6. Erection by specialists in this type of boiler assures quality production that is an inherent factor in long-term economical operation. Considerable saving in erection cost is obtained because the boiler is a self-contained steam-generating unit—assembled in the shop and shipped to the customer completely assembled. The unit includes the boiler proper, burner, forced-draft fan, feedwater, regulator, valves, soot blower, refractory, insulation and all other accessory equipment—ready to generate steam.

Installation time is saved because costly and time-consuming erection of the boiler in the field is eliminated . . . . installation connections are limited to fuel, electricity, water, steam, and stack. Hence there is a minimum of outage time or interference with plant operations while the units are being installed.

The FM boiler is easily moved because the completely assembled boiler may be shipped conveniently by rail, or by truck, as shown in Figs. 7 and 8. At its destination it may be lifted into position or skidded into place as desired. The type FM boiler can be easily moved from one plant location to another, if plant conditions require. Sometimes a boiler is used to furnish steam needed during construction stages of a new plant and later is incorporated into the building as a permanent unit for furnishing steam to heat the building.

Completely shop-assembled steam-generating units are available in standard sizes for loads ranging from 5800 to 28,000 lb. of steam per hr., at pressures up to 250 p.s.i. Units for higher pressures and units with superheaters have been built for special applications. Some units have been equipped with air heaters and economizers to provide additional advantages in operation in specific installations.

INSTALLATIONS OF FM BOILERS IN PAPER INDUSTRY

In a corrugated boxboard plant of Union Bag & Paper Corp. in Chicago, additional steam capacity and pressure were required to increase the production of boxboard. This was accomplished by installing a type FM boiler which was shipped to the plant on a railroad car and delivered to a siding just outside the boiler-room. Being completely assembled, the boiler was skidded into place on a previously prepared concrete mat containing six anchor bolts. Breeching, steam, water, oil, gas, and electrical connections were made and the unit

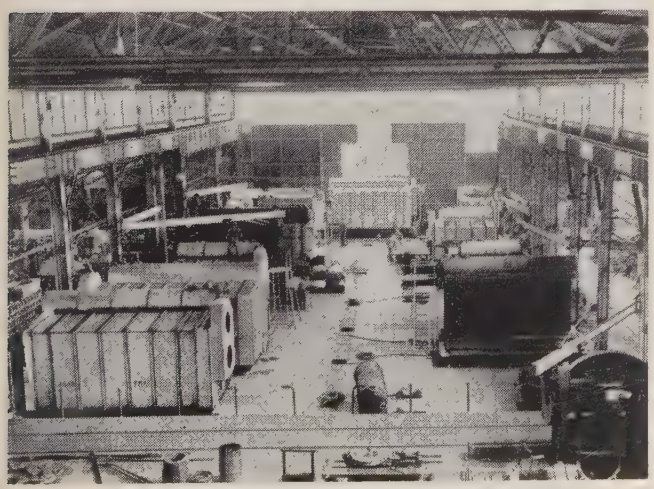

Fig. 6. Assembly space in boiler shop

Fig. 8. Boiler on truck

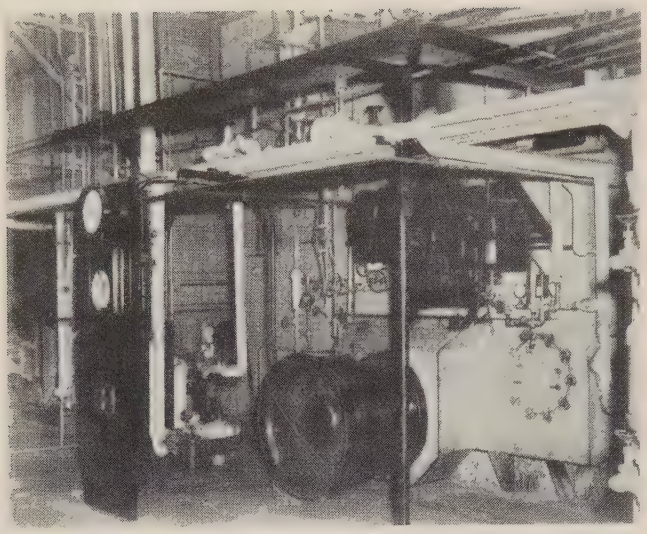

Fig. 9. Boiler installation, Union Bag & Paper Co., Chicago, Ill.

was ready to light off. This unit is shown in Fig. 9. It is designed to generate 15,000 lb. of steam per hour at 200 p.s.i. using oil as fuel. Steam is used for general heating and process requirements. During the Summer, the unit operates at low load because the building heating load is off. The process steam load is intermittent requiring frequent starts and stops. The unit is completely automatic including gas lighters (using bottled gas) and safety interlocks. The "programming control" can be started by push-button or automatically when steam pressure falls below a predetermined point. If the low water cut-out is satisfied that there is enough water in the boiler and if the oil temperature thermostat is satisfied that the fuel oil is at the right temperature, the burner and fan motors start and the gas pilot light is ignited. In the meantime, if the flame rod has been satisfied by the gas pilot light, the oil valve opens and the oil burner is ignited. If the electric eye is satisfied by what it sees at the oil burner, the controls continue the boiler in service, regulating the flow of oil and air to maintain steam pressure. If any of the steps in the starting sequence is not satisfied, the interlock system will shut the unit down, and it can't go through the complete starting-up cycle again until the fault is

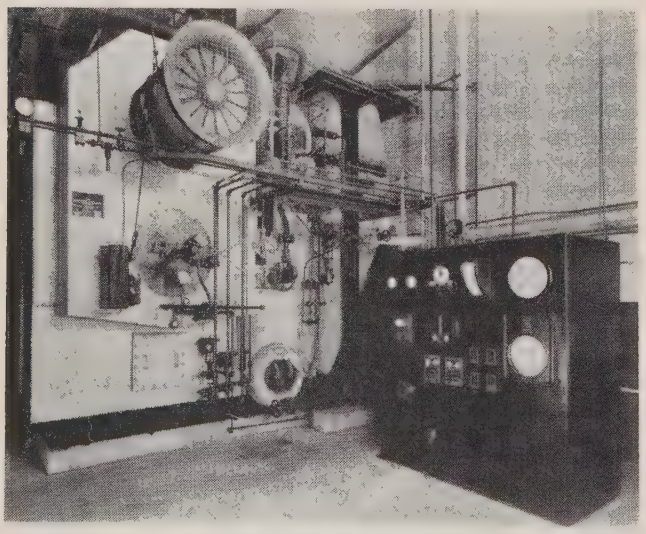

Fig. 10. Boiler installation, Hinde & Dauch Paper Co., Detroit, Mich.

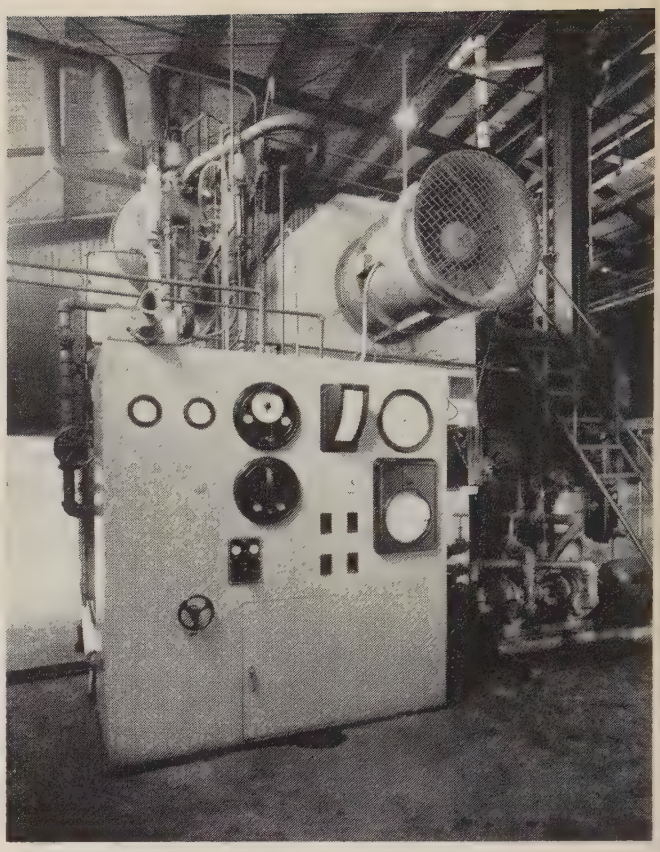

Fig. 11. Boiler installation, E. Werner, Jr., Inc., Ridgefield Park, N. J.

corrected. Each step in the program control must be satisfied before the next step takes over.

Units with automatic controls and safety interlocks are simple to operate, but the control mechanisms should be checked each day to make sure that they would function properly upon failure of water supply or failure of ignition. If the automatic controls and safely interlocks do not function properly the unit should be placed on hand control under the constant supervision of a licensed operator, or taken out of service until the controls are repaired. These precautionary measures should be followed on all automatically fired boilers, regardless of type or manufacture.

The fuel economy of this type of unit is strikingly illustrated by comparing fuel bills before and after the new unit was in operation. In the January–June pe-

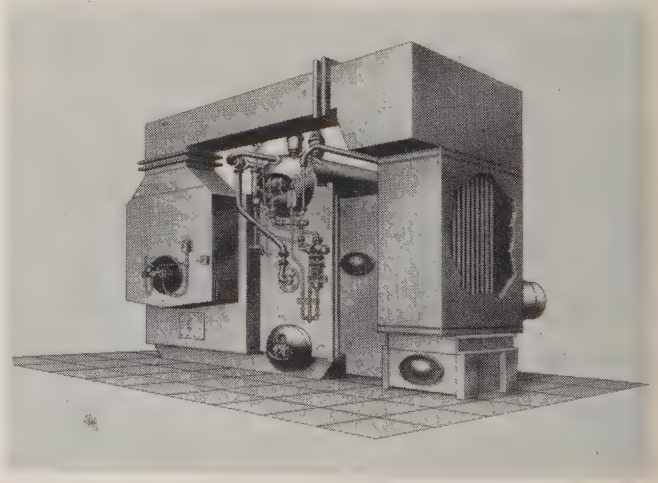

Fig. 12. FM Boiler with air heater

riod of 1950 the fuel bill for an old stoker-fired boiler that generated 26,873,000 lb. of steam in that period was $21,224. In the January–June period of 1951 with a new shop-assembled oil-burning unit in service, the fuel bill for 27,960,000 lb. of steam was $14,665, a saving of $6559 during a similar 6-month period. With such savings, the new unit will pay for itself in a few years.

Another example of an application of shop-assembled automatic boilers is shown by Fig. 10. This unit is installed in a box plant of Hinde & Dauch Paper Co. in the Detroit area, that required additional steam capacity. The unit is designed to generate 20,000 lb. of steam per hr. at 170 p.s.i., furnishing heating and process steam for the expanded plant which was previously supplied by a small brick-set three-drum bent-tube boiler fired with oil but having only hand control of fuel and air supply. During February, March, April, and May of this year, the fuel cost per thousand pounds of steam generated by the new boiler was reduced 25% as compared to a similar operating period in 1951. Again, there is recorded a fuel saving that results in considerably lower operating costs, which will pay for the new unit in a very short time.

A similar FM boiler was installed by Fiberboard Products, Inc., at their Sumner plant in the State of Washington, where they manufacture paperboard, corrugated, and solid fiber shipping containers and other packaging materials.

In line with their plant betterment and expansion program, this company has included the addition of a new corrugator and other steam-consuming equipment. As the existing boiler plant contained several old water-tube boilers, a careful investigation was made of the possible methods of quickly and economically increasing the steam-generating capacity.

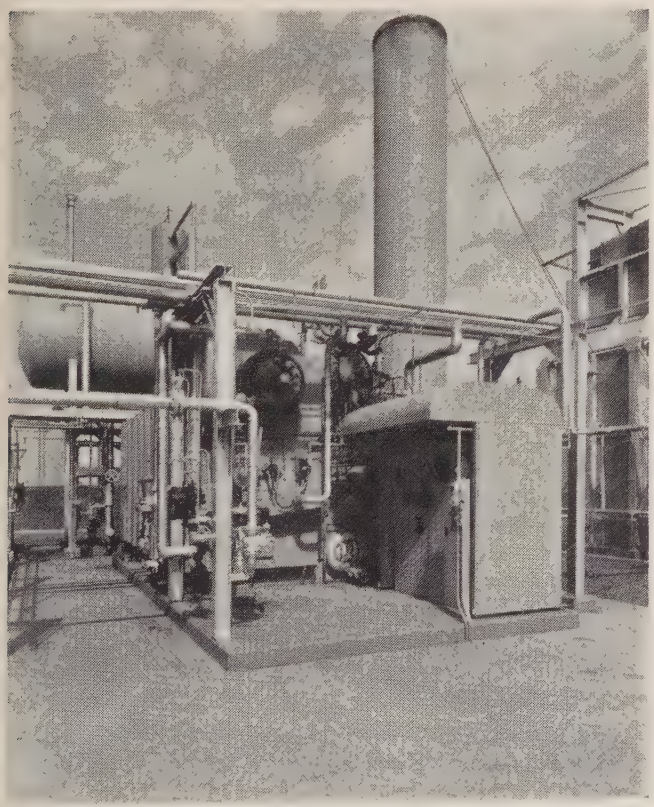

Fig. 13. Outdoor installation of FM boiler

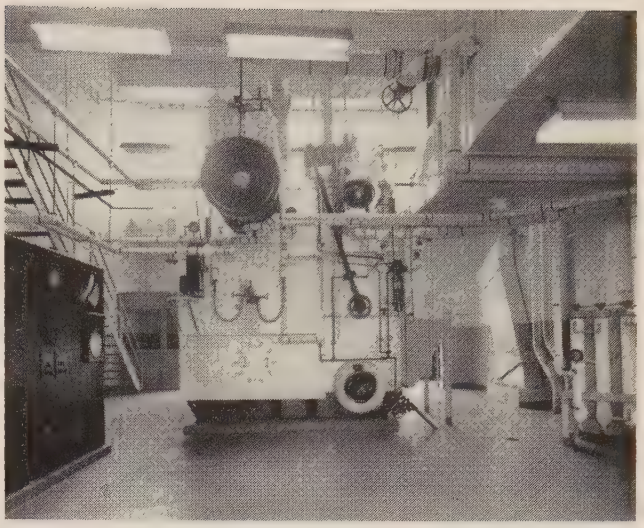

Fig. 14. FM shop assembled boiler

The plant engineers became interested in the possibility of installing a shop-assembled water-tube boiler even though units of this type were just coming on the market and were considered an innovation in the paper industry. The simplicity of such a unit with its low initial cost and minimum space requirements permitting installation in the existing boiler house was an attractive consideration. An oil-fired FM boiler, rated at 18,000 lb. of steam per hr. at 185 p.s.i. operating pressure (250 p.s.i. design pressure) was installed. Fuel savings were quickly realized and the benefits of the abundance of clean dry steam were immediately reflected in plant production.

After the boiler had been in service for a year, an efficiency test was conducted under actual plant load conditions while supplying steam to corrugators and board machine equipment. The results of this test are shown in Table I.

Table I. Test Data, FM-9 Boiler

Total steam generated during test period, lb.	40,300
Average steam load, lb./hr.	14,700
Steam pressure, p.s.i.	181
Feedwater temperature, °F.	223.5
Air temperature, °F.	82.5
Fuel oil temperature, °F.	224
Total oil used during test period, lb.	2,690
CO_2 at boiler outlet, %	13.48
Temperature of gas leaving boiler, °F.	439
Excess air, %	18
Heat value of fuel oil per lb., B.t.u.	18,034
Efficiency (by corrected meter readings of oil consumption and steam generated), %	83.60
Heat balance	
Heat loss due to dry gas, %	7.55
Heat loss due H_2O from combustion, %	5.85
Heat loss due H_2O in fuel, %	0.02
Heat loss due to radiation (ABMA Chart), %	1.80
Unaccounted for (by difference), %	1.18
Total	100.00

The trouble-free operation of the unit, along with its high operating efficiency and low maintenance, has been well established by almost two years of operation.

Figure 11 shows another shop-assembled boiler installed in the new paper mill of E. Werner, Jr., Inc. in Ridgefield Park, N. J. The boiler furnishes steam for process and the turbine drives of paper machines in a

plant that manufactures heavy paper and cardboard from wastepaper. The unit is designed to generate 28,000 lb. of steam per hr. and operates 24 hr. per day. Oil is burned in Y-jet burners. Automatic combustion control regulates fuel and air supply to satisfy the load demand, maintaining steam pressure of 170 p.s.i. in the drum at all loads. Bottled gas is used in the automatic lighters for lighting-off oil burners. The control system is equipped with safety interlocks which operate when ignition fails at the burner or when there is insufficient water in the drum. The interlock system also actuates audible alarms, a bell for low water, and a horn for ignition failure.

CONCLUSIONS

There are many other similar applications of shop-assembled boilers in the paper industry. These can generally be classed as boiler installations in: (1) small pulp mills and paper mills for the main source of steam, and in (2) large paper mills or pulp mills as a quick expedient for obtaining more steam.

There are hundreds of small paper mills that use less than 100,000 lb. of steam per hr. For these, the FM boiler is especially suitable as the primary source of steam. For the other condition of a large pulp or paper mill that urgently needs 15,000 to 28,000 additional lb. of steam to help increase paper production, an FM boiler can fill their needs quickly and economically. In some cases, FM boilers are installed temporarily for a few years on the basis that they can be easily moved elsewhere or sold when no longer needed. Installing new modern FM boilers is more economical, even for temporary service, than buying second-hand boilers of older design, as has been done in many cases.

For those installations where maximum efficiency is desired by absorbing additional heat from the stack gases before they are discharged to atmosphere, thus further reducing fuel consumption, an air heater, or an economizer can be added to the unit. Figure 12 shows an application of an air heater.

As stated before, the standard casing construction is suitable for installation outdoors, eliminating the need for a building over the boiler. Figure 13 shows an outdoor installation in the southwest.

It is believed that the shop-assembled integral furnace boiler, type FM, Fig. 14, meets a definite need in small and medium-sized plants, and also in those larger plants where skilled boiler operators are scarce. These latter plants may find it advantageous to have several shop-assembled boilers rather than a smaller number of larger "tailor-made" designs requiring complete field erection. The lower fuel consumption plus the saving in expense, labor, and time, and the elimination of a sometime speculative item of erection labor from the installation cost may well justify their selection.

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A Catalytic Oxidation Procedure for Determining Sulphur Compounds in Kraft Mill Gases

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The sources of kraft mill odors and atmospheric sulphur losses are reviewed, together with various analytical procedures for measuring sulphur compounds in the gas streams. These methods include the precipitation techniques with mercury and cadmium salts for differentiating between hydrogen sulphide, mercaptan, and dimethyl sulphide; the potentiometric silver electrode-silver nitrate titration for inorganic sulphide and methyl mercaptan; the bromine-oxidation method of Siggia and Edsberg for determining alkyl sulphides and disulphides. A rapid method is described for measuring the total sulphur and sulphur dioxide, and the difference is considered to be the sulphide-type sulphur consisting of hydrogen sulphide, alkyl mercaptan, and sulphides. The method is based on the catalytic oxidation of the sulphur compounds in a quartz combustion tube at 1000 °C. to sulphur dioxide, the sulphur dioxide in turn is oxidized to sulphuric acid in a hydrogen peroxide absorption solution, and the acid is determined by changes in pH. Individual tests can be made in less than a minute and the procedure can be used for continuously recording the sulphur content of gas streams. The method is capable of detecting a fraction of a part per million, and by proper dilution, gas streams containing several hundred thousand parts per million can be measured. A definite volume of gas can be tested in the analyzer, or tests can be made continuously. Sulphur dioxide in the original gas sample is determined by by-passing the combustion tube. Tests are described on various known concentrations of hydrogen sulphide, dimethyl sulphide, carbon disulphide, sulphur dioxide, and mixtures containing methyl mercaptan. The method has been applied to most of the gas streams found in kraft pulping operations including stack gases, lime kiln gases, digester relief and blow gases, evaporator vents, and building ventilation.

The evaluation and control of sulphur losses in sulphate pulping and recovery operations have been limited by the availability of adequate and convenient testing procedures. These sulphur losses are the source of the serious odor nuisance problems associated with this type of pulping operation. It has long been known that the objectionable gases which cause kraft mill odors are primarily hydrogen sulphide, methyl mercaptan, and dimethyl sulphide, along with oxidation products of the same. These compounds can be detected by the human sense organs in extremely dilute concentrations. Thorough investigations by the U. S. Public Health Service (*14*) have shown that the odor threshold detection

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values of hydrogen sulphide, methyl mercaptan, and dimethyl sulphide are 1.1 μg. per liter. This is somewhat less than 1 p.p.m. on a weight basis. These figures become more readily visualized when we consider that if 1 lb. of these materials is evenly dispersed in an air volume over 1 acre in area to a height of 300 ft., they could still be detected by the sensory organs.

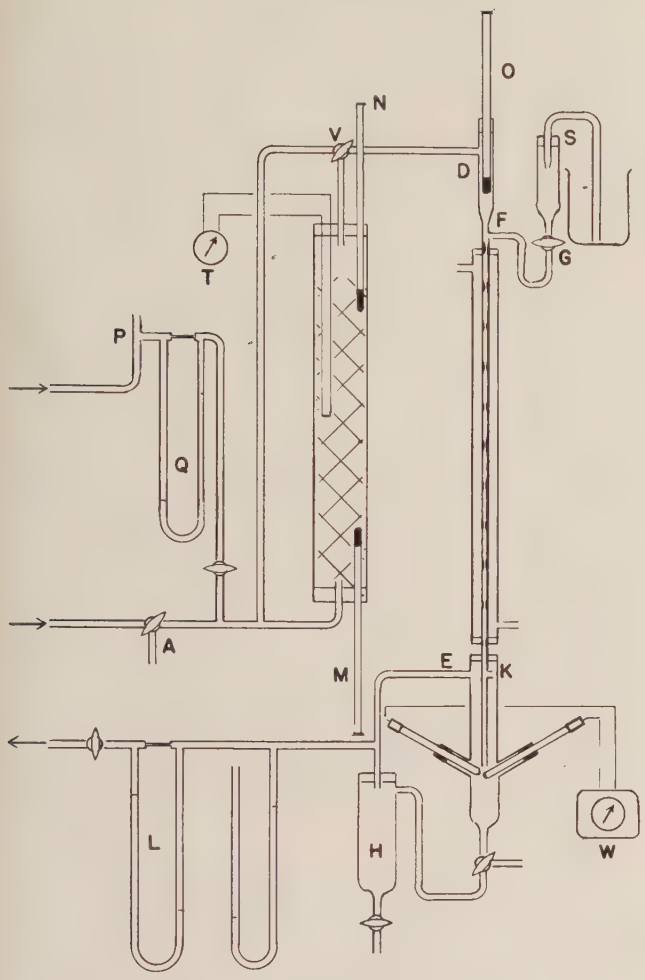


Fig. 1. Analyzer

There are many conflicting reports in the literature and opinions vary among operators as to the intensity, immediate source, and kind of the various materials contributing to the kraft mill odor problem. However, this may be due to the efficiencies of the various types of equipment used in different plants and the methods of operation. In general, the main source of odors are the furnace stack gases, the digester relief and blow gases, the lime kiln gases, and the noncondensable gases from the evaporators. Organic sulphur compounds such as methyl mercaptan and dimethyl sulphide are produced as side reactions during the latter part of the pulping operations.

Bergstrom and Trobeck (*3*) have determined the loss of volatile organic sulphur compounds associated with the digester relief and blow and have reported a total loss equivalent to about 2 lb. of sulphur per ton of pulp.

In the pulping of Douglas-fir we have found that organic sulphur compounds of this type are produced in the order of 1 to 5 lb. of sulphur per ton of pulp, depending upon the pulping conditions. The maximum cooking temperature appears to be the most critical factor in fixing the amounts of these materials produced. Higher temperatures favor the production of these compounds. These organic sulphur compounds have very high vapor pressures and they readily escape to the atmosphere during digester relief and blowing and under conditions of stock manipulation and liquor evaporation. Some of these materials are partially condensed with the steam and appear in the digester relief and blow condensates and also in the evaporator condensates, but the balance escapes to the atmosphere in the form of noncondensable gases.

The recovery furnaces coupled with the direct contact evaporators are a major source of hydrogen sulphide. Under ordinary conditions the black liquor contains some residual sodium sulphide and in passing through the direct contact evaporators this material can be readily displaced by the carbon dioxide and sulphur dioxide in the flue gases. The stabilization of the black liquor by oxidation results in a considerable reduction of the hydrogen sulphide losses, as far as the cascade evaporator is concerned (*4*). On a weight basis the hydrogen sulphide losses from the recovery operations are of a much greater magnitude than the organic sulphur compound losses from the digestion steps.

REVIEW OF TESTING METHODS

In the various kraft mill gas streams these sulphur compounds are mixed with inert gases which oftentimes make the analysis difficult. Many times the concentrations are extremely low. In the stack gases we have the usual combustion products from the furnace along with some sulphur dioxide and some volatile unburned organic products. In the digester relief and blow gases other volatile organic products are present along with much water vapor. In selecting analytical methods care must be exercised in interpreting results since some of these extraneous compounds can influence the sulphur compound determination. Oxidation techniques for measuring reduced sulphur are affected by the reducing action of these other or-

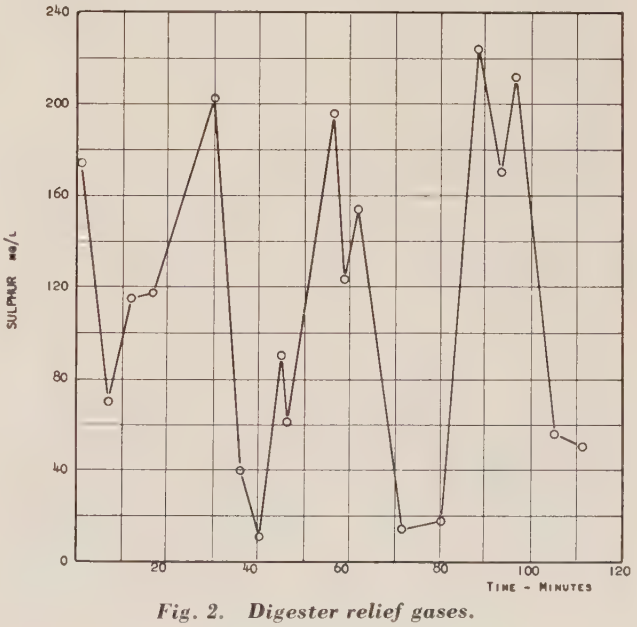


Fig. 2. Digester relief gases.

ganic compounds. Likewise, precipitation techniques involving heavy metal complex formations are affected by the concentration of the reagents. In the presence of oxygen it is often advisable to complete the analyses as rapidly as possible since under wet conditions hydrogen sulphide is oxidized to elemental sulphur and the mercaptans are converted to disulphides. Flame combustion techniques with conversion to sulphates such as are used on gaseous and liquid fuels are cumbersome and not well adapted to kraft mill gases. On relief and digester gases an Orsat-type procedure involving dry ice condensation was found to be of considerable value in this laboratory. The organic sulphur compounds are condensed and measured by difference, but here again other organic compounds are condensed with this treatment so that the test cannot be considered specific for sulphur compounds. In the following discussion the most generally used analytical procedures are reviewed.

Precipitation Techniques

Methods for determining the concentrations of hydrogen sulphide, methyl mercaptan, and dimethyl sulphide, based on the selective absorption in an acidified cadmium chloride solution, a mercury cyanide solution, and a mercury chloride solution (*2*) are more suitable for digester relief gases than for flue gases. The method does not give quantitative recoveries. Certain minimum concentrations of both methyl mercaptan and dimethyl sulphide, often exceeding the concentrations found in recovery furnace stack gases, are necessary to produce a precipitation with the dissolved mercury salts. The precipitates are rather unstable when washed and dried. Dimethyl disulphide precipitates in the same solution as dimethyl sulphide. However, the ratio of dimethyl disulphide to mercury chloride in the precipitate is higher than the ratio of dimethyl sulphide to the mercury salt. In addition, the ratio changes while the absorption proceeds and the mercury chloride concentration of the absorption liquid decreases.

Potentiometric Method

The potentiometric determination of sulphides and mercaptides in alkaline solution is described by Tamele, *et al.* (*12*). A modification was used to determine the hydrogen sulphide and mercaptan content of gases. The equations of the reactions are as follows:

$$S^{--} + 2Ag + \rightarrow Ag_2S$$
$$CH_3S^- + Ag + \rightarrow AgSCH_3$$

The method requires the absorption of the sulphur compounds in an alkaline solution. The absorption and titration should be performed fairly rapidly so as to avoid significant oxidation of the dissolved mercaptides and sulphides. In order to provide for convenient sampling and absorption, a technique was used in which no suction pump or flowmeter was required at the source of gas.

The procedure used is as follows: 250 ml. of 2 *N* sodium hydroxide are transferred to a 5-liter round flask. A stopcock is attached to a tube in the stopper of the flask. The flask is evacuated and is taken to the source of gas. The gas is drawn into the flask by opening the stopcock. An almost complete absorption of the hydrogen sulphide and mercaptans in the alkaline solution is achieved by shaking vigorously for 30 sec. The ionization constant of methyl mercaptan at a pH of 13 is 2.2×10^{-11}. This indicates that approximately 99% of the mercaptan is present as the sodium salt (*12*).

The temperature and pressure of the gas in the flask should be noted after the flask is evacuated and after the absorption is completed. The exact volume of the gas sample can then be calculated for normal conditions. The volume of the absorption liquid is taken into consideration. The rubber stopper and stockcock are removed from the flask and the dissolved sulphides and mercaptides are poured into a beaker, using about 150 ml. of additional water. The solution is made approximately 0.05 *N* with respect to ammonia by the addition of strong ammonium hydroxide solution. The presence of ammonia prevents the precipitation of silver oxide. An alkaline resistant glass electrode and a silver-silver sulphide electrode are immersed in the solution and the titration with 0.1 *N* silver nitrate is started while the solution is gently stirred. The end point is not taken at the inflection point of the curve, but at the most negative potential value of the almost linear descending position of the titration curve. The determination, including the absorption of the gas sample, can be carried out in less than 20 min. Occasionally a 12-liter round flask was used instead of the 5-liter flask.

Hydrogen sulphide is precipitated as black silver sulphide at a considerably more positive potential than the light-colored methyl mercaptides. Therefore, hydrogen sulphide cannot be readily confused with other compounds.

Errors may arise from various sources like oxidation of the sulphur compounds in the presence of oxygen, the reaction of dissolved sulphur dioxide (*7*) and hydrogen sulphide and unsuitable electrodes. The electrodes should be tested periodically. Titrations of solutions containing known amounts of H_2S or CH_3SH enable one to control the conditions of the alkaline resistant "blue point" glass electrode and in particular the silver-silver sulphide electrode. To standardize the solution, a known volume is pipetted below the surface of an excess of 0.1 *N* iodine acidified with hydrochloric acid. The iodine is titrated to a starch end point with 0.1 *N* sodium thiosulphate. The results of the potentiometric titrations are generally 5 to 10% on the low side.

The potentiometric method outlined above is more suitable to investigate the recovery furnace flue gases than the digester relief gases. The latter gases contain, besides mercaptans, a considerable amount of dimethyl sulphide and little hydrogen sulphide. Dimethyl sulphide cannot be determined directly by titration with silver nitrate. Therefore, the potentiometric method applied on the digester relief gases gives incomplete results and consequently no exact statement can be made concerning the total amount of sulphur compounds present.

Bromine Oxidation

Siggia and Edsberg have devised a method for the determination of alkyl sulphides and disulphides (*11*). The reactions involved are as follows:

$$RSR + Br_2 + H_2O \rightarrow R_2SO + 2HBr$$
$$RSSR + 5Br_2 + 4H_2O \rightarrow 2RSO_2Br + 8HBr$$

The oxidation is carried out by adding a bromate-bromide solution to the acidified solution of the sulphides and disulphides. Bromine water would perform the same reaction as the bromate-bromide solution.

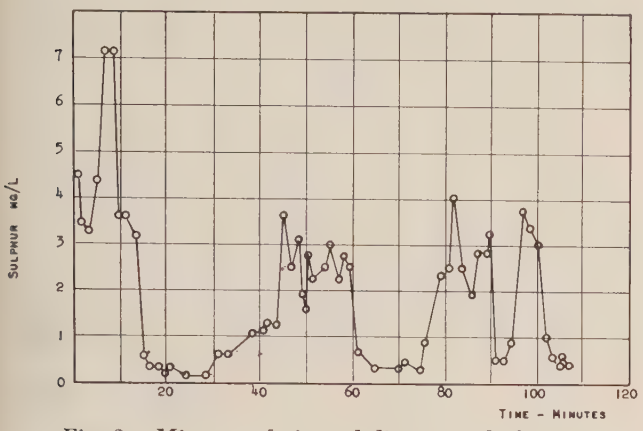


Fig. 3. Mixture of air and digester relief gases

However, a standard bromine solution is too unstable as bromine vapors are continually lost from the solution.

The endpoint of the titration is indicated by the bromine color. When the original solution is already colored, the end point can be indicated potentiometrically by using a gold electrode and a calomel electrode.

Mixtures of alkyl mercaptans, sulphides, disulphides, and some hydrogen sulphide are found in the digester relief gases of a kraft mill. The mercaptans and the hydrogen sulphide have to be separated from the organic sulphides and disulphides. The reactions of hydrogen sulphide and alkyl mercaptans with bromine are as follows:

$$H_2S + Br_2 \rightarrow S + 2HBr$$
$$2RSH + Br_2 \rightarrow RSSR + 2HBr$$
$$RSSR + 5Br_2 + 4H_2O \rightarrow 2RSO_2Br + 8HBr$$

The disulphides can be determined separately by reducing this compound to the alkyl mercaptans. The mercaptans are determined by titration with silver nitrate.

The bromate-bromide procedure gives good results when applied on pure solutions of sulphides or disulphides. However, exploratory investigations showed that the titration of a solution containing condensed and absorbed digester relief gases, produces results that are too high. For instance, the relief gases of a soda cook containing no sulphur, were absorbed and titrated. A significant amount of bromate-bromide solution was used, although no sulphur compounds were present. The end point was not permanent and therefore difficult to define.

The colorimetric determination of hydrogen sulphide based on the formation of methylene blue has long been known. Methylene blue is obtained by the reaction of *p*-amino-dimethylaniline (*1*, *5*) or Bindschedler's Green (*15*). These methods give good results especially when applied on solutions containing hydrogen sulphide only. However, other sulphur compounds like dimethyl sulphide, a major component of the digester relief gases, are not indicated. In addition, sulphur dioxide present in the flue gases tends to decrease the hydrogen sulphide content after the gases have been dissolved prior to the color reaction (*7*).

The above procedures can be used to advantage in characterizing the constituents of kraft mill gas streams. However, these procedures are time-consuming and oftentimes the composition of the streams changes very rapidly. This is not only true of digester relief and blow gases, but there are also rapid fluctuations in composition in stack gases. In developing processes for converting or minimizing these foul gas constituents the ultimate goal is frequently the conversion to sulphur dioxide. In evaluating the efficiencies of such a process it is often necessary to distinguish between the oxidized and unoxidized forms of sulphur. A suitable testing procedure would be one that is almost automatic and very rapid and one which would cover a range of concentrations from a fraction of a microgram per liter to concentrations up to several hundred thousand micrograms per liter. The precision of the method should be close enough for practical purposes to distinguish concentrations within 5% over this very broad concentration range. For practical purposes one can consider the mercaptan and dimethyl sulphide as substitution products of hydrogen sulphide. In all three of these compounds the sulphur is present as sulphide-type sulphur. In most processing steps it is not necessary to distinguish between hydrogen sulphide, alkyl mercaptans, alkyl sulphides, and alkyl disulphides. It is much more important that facile and rapid methods are available for the determination of the total amount of sulphur compounds and sulphur dioxide. The difference between the total amount of sulphur compounds and sulphur dioxide will primarily represent the odorous sulphur compounds normally found in kraft mill gases.

In surveying the literature it can be noticed that the petroleum gas industry had to cope with similar analytical problems. The sulphur content of the gases involved is determined either by hydrogenation or oxidation methods. The hydrogenation method (*6*, *8*, *10*) is a suitable method to determine very low concentrations in synthesis gas. The sulphur compounds are converted

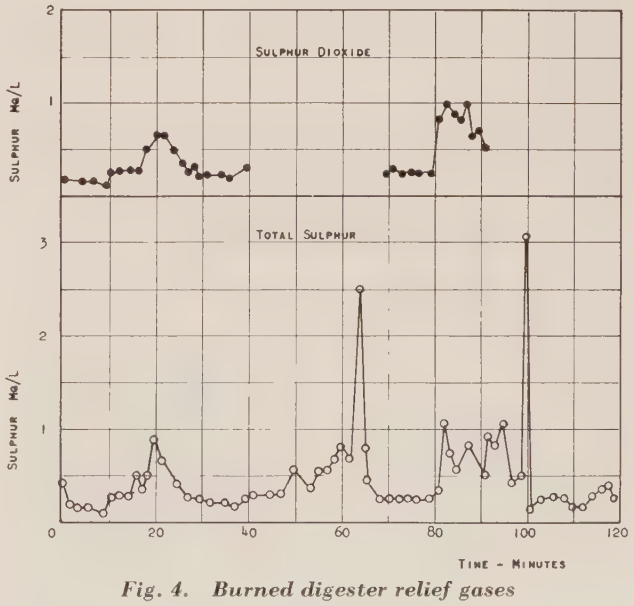


Fig. 4. Burned digester relief gases

to hydrogen sulphide and this in turn can be measured colorimetrically. However, on kraft mill gases the hydrogenation techniques are limited in scope by the interference of oxygen which is present in most types of

gas. The oxidation method is based on the complete conversion of the hydrogen sulphide and organic sulphur compounds to sulphur dioxide. Although combustion has been used extensively for analytical purposes and to some extent in the elimination of kraft mill gases no applications are known to the authors in which such a conversion is used in analyzing kraft mill gases. Zahn (*16*) has used a modification of the ASTM lamp method using purified air for combustion and the turbidimetric estimation of sulphur as barium sulphate. A method described by Hambersin (*8*) involves the conversion of sulphur compounds in a combustion tube to sulphur dioxide, the oxidation of the dioxide to sulphuric acid and the determination of sulphuric acid by direct titration or as barium sulphate. Katz (*9*) has described a photoelectric determination procedure for atmospheric sulphur dioxide. The method described by Thomas (*13*) concerns an automatic apparatus for measuring small concentrations of oxidized sulphur compounds in air.

THE CATALYTIC OXIDATION PROCEDURE

In the present procedure a measured gas stream containing the sulphide-type sulphur along with oxidized sulphur compounds is passed through a combustion tube and all of the sulphur compounds are oxidized to sulphur dioxide. The stream is then passed through a controlled amount of standard absorption solution containing hydrogen peroxide at a controlled pH and the sulphur is converted to sulphuric acid. This additional sulphuric acid alters the acidity of the absorption solution and the observed difference in acidity is used as the measure of the total sulphur in the gas stream. A similar determination is made by by-passing the combustion tube and this figure represents the sulphur dioxide in the gas stream. The difference between these two values represents the sulphide-type sulphur in the gas stream. The changes in acidity can be determined in various ways, but for simplicity we have employed a pH meter with very small electrodes to accommodate the small volumes of absorption liquid involved. The details of the sampling and testing technique are as follows.

The recovery furnace gases contain a considerable amount of dust and entrained solids which can plug the equipment and cause false results. A special combination of glass wool and sintered glass filters at the end of a sampling tube was used to filter the dust from the gas stream. The sampling tube was enclosed in a jacket.

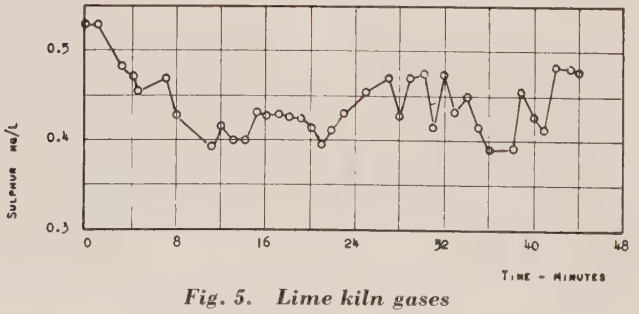


Fig. 5. Lime kiln gases

Most of the gas streams encountered in plant operation are heavily laden with moisture, usually at high temperatures, and it is necessary to prevent condensation by cooling. The flue gases contain up to 30% water vapor and the relief gases are practically saturated. Hydrogen sulphide and sulphur dioxide are very soluble in this condensate and in order to prevent condensation of moisture the sample tubes are electrically heated to a temperature of about 100°C.

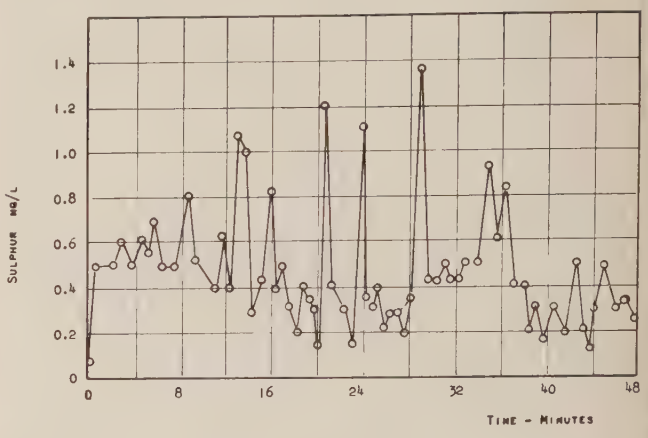


Fig. 6. Stack gases.

The digester relief gases contain very little oxygen and they are rich in organic compounds—in some gases up to 40% by volume. The combustion of these compounds requires the addition of oxygen. In order to overcome the difficulty encountered with explosive mixtures, about 20 volumes of air or oxygen are added after the relief gas flow has been measured in a special flowmeter. The resulting dilution is sufficient to reduce the concentration below the limits of inflammability.

In operation the sampling tube is inserted into the duct under investigation so that the end of the tube including the dust filters reaches well into the gas stream. It was possible to maintain the desired sampling flow continuously for periods of several hours without plugging. The rate of sampling depended upon the initial concentration of the gas. For extremely low concentrations of sulphur in the gas stream, large volumes of gas are required with correspondingly low volumes of absorption liquid. For gases rich in sulphur the gas volumes can be reduced and the volume of absorption liquid can be readily adjusted to arrive at measurable differences in acidity of the final test solutions. Separate flowmeters were employed to measure the sample gas flow, the total gas flow, and the flow of supplemental oxygen required for the complete combustion of the hydrogen sulphide and organic compounds.

The complete combustion train is shown diagramatically in Fig. 1. The heating elements are omitted for clarity. The combustion tube is 60 cm. long and 22 mm. inside diameter and consists of fused quartz or silica. Quartz and silica combustion tubes are more satisfactory than glass tubes because they can be operated at higher combustion temperatures. Electrical units have been found to be the most satisfactory means for heating the combustion tube. The central section of the combustion tube containing the catalyst is wound and heated by an 800-w. Nichrome heating wire and a suitable resistance is placed in the circuit to control the desired temperature. Heating elements

are placed on both ends of the tube to maintain a temperature at least as high as the temperature of the sampling tubes. Asbestos is used to insulate the central section. A calibrated thermocouple, T, is employed to measure the temperature of the central section and glass thermometers N and M show the temperatures at the tube ends. A temperature of 950 to 1000°C. has been found satisfactory for the different types of compounds tested and this temperature was used throughout our work.

The walls of the combustion tube act as a catalyst, but to insure complete conversion the tube is packed with crushed quartz or silica to provide a larger surface area. The combustion-train parts are all made of glass with standard ground glass connections except for the combustion tube itself. The ends of the combustion tube are sealed with corks cemented with cellulose acetate coating.

The change in concentration of recovery furnace flue gases and the digester relief gases is very rapid. In order to obtain a good pattern of the concentration changes a rapid response of the instrument to gas changes is required. The rate of response depends primarily on the time necessary to displace the liquid in the absorber and the measuring cell. The displacement rate is high when the volume of liquid contained in these vessels is small and the flow of the liquid through the vessels is high. The movement of the gas and the liquid in the same direction greatly facilitates the rapid flow of the liquid through the absorption system. The absorber consists of a glass tube 45 cm. long with an inside diameter of 5 mm. The tube is constricted at regular intervals of $2^1/_2$ cm. The entire absorption tube is water jacketed to cool the liquid and absorption gases. The gas enters the absorbers through D and leaves at E. The absorbing solution containing 0.3% hydrogen peroxide and a predetermined amount of sulphuric acid is drawn into the tube at F. A vacuum of 15 cm. of mercury is maintained on the entire system so that a steady flow of liquid after adjustment passes through the stopcock G. A decline of 1 cm. in the liquid level in the supplying beaker causes a decrease of liquid flow of less than 1%. To prevent condensation between the combustion tube and the absorber this glass connecting section is electrically heated similar to the sampling tubes.

A sufficient amount of sulphuric acid is added to the absorption liquid in order to eliminate the influence of carbon dioxide on the pH measurements. The original pH of the liquid is adjusted to 3.5 with sulphuric acid. The acidified absorption liquid flows over the tips of a small glass electrode and a calomel electrode. The liquid covers the glass electrode completely. A pH meter, W, indicates the acidity of the absorbing liquid. The cell is equipped with a thermometer. It is frequently necessary to make measurements near furnaces where the prevailing temperature is usually high. In case uncertainty exists with regard to the performance of the cell and the meter at higher temperatures, it is a relatively simple operation to obtain a calibration curve by successively pouring a series of solutions of known concentrations of sulphuric acid into the funnel S while oxygen instead of gas passes through the analyzer. The liquid flows from the measuring cell to a calibrated accumulating vessel H. The level of this vessel is recorded periodically. The gas and the absorption liquid are separated in the T-tube at K. The gas flow is measured by the flowmeter L and passes to a vacuum pump provided with a vacuum regulator.

Table I. Combustion of Various Sulphur Compounds

Material tested	*Flow rates* — *Gas, l./min.*	*Liquid, ml./min.*	*Sulphur inserted, µg./l.*	*Sulphur recovered, µg/l.*
Sulphur dioxide	0.8	1.0	10	10
	0.8	1.0	4.5	4
	0.8	1.0	2	2
	0.8	1.0	15	14
Carbon disulphide	0.7	1.2	14	14
	0.7	1.2	15	14
	0.7	1.2	15	14
	0.7	1.2	8	8
Dimethyl sulphide	0.75	1.3	25	24
	0.75	1.3	13	13.5
	0.75	1.3	3	3
	0.75	1.3	16	15
Hydrogen sulphide	0.8	1.5	24	22
	0.8	1.5	14	12

Table II. Combustion of a Mixture of Sulphur Compounds

Mixture tested	*Flow rates* — *Gas, l./min.*	*Liquid, ml./min.*	*Sulphur inserted, µg./l.*	*Sulphur recovered, µg./l.*
Methyl mercaptan	0.7	1.2	13	
Dimethyl sulphide			9	
Carbon disulphide			14	
Dimethyl disulphide			12	
Total			48	45

Procedure

The temperature of the combustion tube is adjusted to 950 to 1000°C. as indicated by the thermocouple. The sampling tubes and connections are heated to a temperature of about 100°C. The thermometers M, N, and O are provided to measure these temperatures. The vacuum pump is started and the regulator is set to maintain a vacuum of 15 cm. mercury on the system. A cylinder of oxygen equipped with a pressure regulator valve is connected to the T-tube. Additional oxygen is supplied over that required and escapes through the open vent of the T-tube. A definite flow of, for instance, 70 ml. per min. is drawn through the flow meter Q into the system. The gas sample under test is then passed through the analyzer at the rate of 0.5 to 0.8 liter per minute by opening the three-way cock A connecting the analyzer with the sampling tube.

The beaker is charged with absorption liquid containing 0.3% hydrogen peroxide and a definite amount of sulphuric acid—for example, 10 p.p.m. The absorption liquid is allowed to flow through the dropper S and the stopcock G into the absorber. The flow rate of the liquid, usually 0.5 to 10.0 ml. per min. depends primarily on the concentration of the sulphur compounds in the gas and the desired rate of response. A change in concentration is indicated by a change in pH measured by the electrodes. The absorption liquid flow is regulated in such a way that the resulting concentrations fall in the pH range of 3.5 down to 1.5 at the lowest. The absorption liquid flow rate is changed only when a readjustment is necessary. The liquid flow is calculated from the periodic recording of the level in the calibrated accumulating flask H. The pH can be recorded as often as desired or convenient. The concentration of the total amount of sulphur compounds is calculated from the gas flow, the sulphuric

Table III. Determination of Total Sulphur (μg./l.)

Air leaving oxidation tower	25
Flue gases entering Bergstrom tower	630
Flue gases leaving Bergstrom tower	660
Gases from duct above washers	25
Evaporator noncondensable gas	2600
Dissolving tank stack	36

acid concentrations of the initial and final absorption liquid, and the absorption liquid volume flow. The oxygen flow added to the gas stream and the small amount of sulphuric acid added to the absorption liquid must be taken into consideration. The effect of dilution of the absorption liquid by condensate is usually insignificant because it affects only the sulphuric acid concentrations of the original absorption liquid. The combustion tube can be by-passed by turning the three-way cock V in the by-pass position when a separate determination of sulphur dioxide content of the gas is required. To secure continuous operation the flask containing the absorption liquid is recharged regularly. In order to prevent the entrance of air into the system (under vacuum) the two connections at the absorber and cell are closed before emptying the accumulating flask H. When a gas containing very high concentrations of sulphur compounds is sampled, such as digester relief gases, a flowmeter for the undiluted gas is placed near the sample point and an excess of air or oxygen is added corresponding to a total volume of 0.5 to 0.8 liter per minute as mentioned under "sampling" above.

The pH measurements can be controlled by closing the stopcock A, and by-passing the combustion tube, and allowing pure oxygen and the absorption liquid to continue to pass through the analyzer. The pH indicated by the meter should equal the known pH of the absorption liquid.

Experimental

To test the method, dilutions of various organic sulphur compounds in nitrogen were passed through the analyzer following the procedure mentioned above. The tests included known concentrations of sulphur dioxide, carbon disulphide, dimethyl sulphide and hydrogen sulphide and a mixture including methyl mercaptan. The results of these tests are listed in Table I and they indicate that good combustion and absorption are obtained. A reduction of the oxygen content of the gases from 20 down to 2% did not affect the results. However, there should be sufficient oxygen available to completely convert all of the sulphur compounds and organic compounds to sulphur dioxide, carbon dioxide, and water. The results of Table II show that the recovery of the sulphur in a mixture of four different compounds exceeds 90%. However, when the same mixture does not pass the combustion tube, but is by-passed directly to the absorber, no change in pH is observed and consequently no sulphur dioxide is formed.

The digester relief gases contain small amounts of ammonia. Tests with nitrogen containing a small amount of ammonia did not produce an alkaline or acid reaction when the gas was passed through the combustion tube in the presence of sufficient oxygen. Evidently the ammonia is destroyed completely and significant concentrations of sulphur dioxide, water vapor, and ammonia do not coexist at the temperatures involved.

Under ordinary circumstances typical kraft mill gases do not contain hydrochloric acid, chlorine, or organic chlorine compounds. These compounds do interfere when present in the atmosphere since hydrochloric acid produces a similar decline in pH as does sulphuric acid. It is possible, therefore, that the determinations of total sulphur compounds or sulphur dioxide in an atmosphere near a bleach plant might also include chlorine compounds.

Applications

Tests have been made on various types of gas streams encountered in various parts of the kraft mill. In Table III some typical determinations are listed covering sulphur loadings over the range of from 25 to 2600 μg. per liter.

Figure 2 shows some periodic tests made on digester relief gas after the relief condenser. These tests show the variability in concentration when a number of different digesters at different stages of cooking are relieving into the system. One should bear in mind that the relief gas flow under these conditions is also varying.

Figure 3 shows similar digester relief gases after a 10 to 15 fold dilution with air prior to burning. In Figs. 2 and 3 the sulphur is present as sulphide-type sulphur with practically no sulphur dioxide.

Figure 4 shows some experimental tests on the burning of relief gases. The chart is divided into two parts showing both total sulphur and sulphur dioxide, and an examination of the figures will show that the bulk of the sulphur after burning is in the form of sulphur dioxide.

Figures 5 and 6 show the total sulphur in the stack gases from the furnace and the lime kiln, respectively. The sulphur dioxide content was insignificant in both cases, so that the values represent reduced sulphur, primarily hydrogen sulphide. Considering the large gas volumes involved, these sulphur losses are very significant. The rapid and wide fluctuations in the sulphur content of the stack gases have been observed many times, and this is probably due to localized combustion conditions within the furnace.

LITERATURE CITED

1. Almy, L. H., *J. Am. Chem. Soc.* 47: 1381 (1925).
2. Bergstrom, H., and Trobeck, K. G., *Svensk Paperstidn.* 42: 554 (1939).
3. Bergstrom, H., and Trobeck, K. G., *Svensk Paperstidn.* 48: 49 (1945).
4. Bialkowsky, H. W., and DeHaas, G. G., *Paper Mill News* 74, No. 35: 14 (1951).
5. Fogo, J. U., and Popowsky, M., *Anal. Chem.* 21: 732 (1949).
6. Field, E., and Oldach, C. S., *Ind. Eng. Chem., Anal. Ed.* 18: 668 (1946).
7. Karchner, J. H., and Dunahoe, J. W. *Anal. Chem.* 20: 915 (1948).
8. Hambersin, J., *Bull. Soc. Chim. Belge.* 56: 131 (1947).
9. Katz, M., *Anal. Chem.* 22: 1040 (1950).
10. Meulen, H. ter, *Rec. trav. chim.* 41: 112 (1922).
11. Siggia, G., and Edsberg, R. L., *Anal. Chem.* 20: 938 (1948).
12. Tamele, M. W., Ryland, L. B., and Irvine, V. C., *Ind. Eng. Chem., Anal. Ed.* 13: 618 (1941).
13. Thomas, M. D., Ivie, J. O., and Fitt, T. C., *Ind. Eng. Chem., Anal. Ed.* 18: 383 (1946).
14. U. S. Publ. Health Serv., Public Health Reports, Jan. 13, 1939.
15. Wright, R. H., Schoening, M. A., and Hayward, A. M., *Tappi* 34: 289 (1951).
16. Zahn, V., *Ind. Eng. Chem., Anal. Ed.* 5: 20 (1933).

ASSOCIATION NEWS AND EVENTS

Fall Conferences

The following conferences of the Technical Association of the Pulp and Paper Industry have been scheduled for the balance of 1953:

Testing Conference: Battelle Memorial Institute, Columbus, Ohio. The tentative dates are Sept. 21–23, 1953. Arrangements have been made to hold a meeting of the Wax Testing Committee. Chairmen of other committees of the Testing Division have been advised about the dates and facilities available at the Battelle Institute. Room reservations should be made at the Neil House in Columbus, Ohio.

Plastics Conference: College of Forestry, State University of New York, Syracuse, N. Y., Sept. 15–16, 1953. Room reservations should be made at the Onondaga Hotel, Syracuse, N. Y.

Fibrous Agricultural Residues Conference: Trenton, Ont., Oct. 8–9, 1953. Reservations for rooms in hotels at Trenton and Belleville should be made with W. H. Palm, Hinde & Dauch Paper Co., Toronto, Ont.

Corrugated Containers Conference: Statler Hotel, New York, N. Y., Oct. 14–15, 1953.

Engineering Conference: Sheraton-Mt. Royal Hotel, Montreal, P. Q., Oct. 26–29, 1953.

Alkaline Pulping Conference: Rice Hotel, Houston, Tex., Nov. 18–20, 1953.

New Association Address

The new address of the Technical Association of the Pulp and Paper Industry and *Tappi* is 155 E. 44th St., New York 17, N. Y.

Eighth TAPPI Engineering Conference

A tentative program for the TAPPI Eighth Engineering Conference was published in the June issue of *Tappi*.

The conference will be held at the Sheraton-Mt. Royal Hotel, Montreal, Que., on Oct. 26–29, 1953.

Douglas W. Ambridge, president of the Abitibi Power & Paper Co., Toronto, Ont., will be the featured luncheon speaker on Wednesday, October 28. The subject of his address will be "The Urgent Need of the Industry."

R. C. Max, engineer for the Factory Insurance Association, Milwaukee, Wis., will present a paper on "Fire Protection of Pulp and Paper Mills" in the Mill Design and Economic Aspects Session.

At the Electrical Engineering Discussion Session scheduled for Monday afternoon, October 26, a discussion of the TAPPI Cable Report led by A. O. Mortenson, St. Regis Paper Co., Pensacola, Fla., will be substituted for the discussion of "Power Requirements of Supercalenders."

Fibrous Agricultural Residues Conference

The Fibrous Agricultural Residues Conference will be held at Trenton, Ont., on Oct. 8–9, 1953. The conference will be sponsored by the Hinde & Dauch Paper Co. of Canada, Ltd. W. H. Palm, vice-president, will be the local chairman.

The central theme will be a round-table discussion on "Crush Resistance and Other Strength Properties of Strawboard."

Room reservations should be made with the Gilbert Hotel or Firhurst Manor in Trenton, Ont., or the Quint Hotel or New Queens Hotel in Belleville, Ont.

Alkaline Pulping Conference

The Alkaline Pulping Committee, Fred Bishop, Southland Paper Mills, Lufkin, Tex., chairman, and the Semichemical Pulping Committee, J. N. McGovern, Forest Products Laboratory, Madison, Wis., chairman, will sponsor a joint conference at the Rice Hotel, Houston, Tex., on Nov. 18–20, 1953.

The tentative technical program of the three sessions of the Alkaline Pulping Program is as follows:

Washing Session

1. "Pressure Washing Operating Data," by a representative of the Sutherland Refiner Corp., Trenton, N. J. Since October, 1952, four new systems have been installed. Practical operating data relating to these units will be reported.
2. "Testing of Pulp for Soda Residual," by William Lodge, Pulp and Paper Research Institute of Canada, Montreal, P. Q. Mr. Lodge has developed a new method, quick and accurate, for the determination of soda residual.
3. "Wash Water and Wash Water Heating Systems," by a representative of the Union Bag & Paper Corp., Savannah, Ga.
4. "Washing of Alkaline Pulp with the Impco Valveless Washer," by Joseph Perkins, Improved Machinery Corp., Nashua, N. H.
5. "The Effect of Digester and Liquor Room Operations on Washing," by Wilbur Orr, St. Regis Paper Co., Pensacola, Fla.
6. "Merits of Four Stage vs. Three Stage Pulp Washing Systems," by F. A. Harper, Hudson Pulp & Paper Co., Palatka, Fla.

Screening Session

1. "Flat Screens vs. the Ahlfors Screen for Bleachable Pine and Hardwood Sulphite Pulp," by Roy Homans and Malcolm Pineo, Brunswick Pulp & Paper Co., Brunswick, Ga.
2. "Operating Data on the Cowan Screen," by James Hair, Crossett Paper Mills, Crossett, Ark.
3. "Operation of the Lindbladt Screen," by F. C. Ratliff, Gaylord Container Corp., Bogalusa, La.
4. "Screening Practice in Sweden," by Mr. Eidner, Swedish Cellulose Co., Stockholm, Sweden.
5. "Centricleaners and Vortraps," by a representative of Riegel-Carolina Pulp Co., Acme, Calif.
6. "Utilization of Screen Rejects," by a representative of the North Carolina Pulp Co., Plymouth, N. C. This paper will discuss re-refining and rescreening of screen rejects.

General Session

1. "Utilization of the Peabody Scrubber for the Recovery of Lime Dust," by Henry Vranian, Chesapeake Corp., West Point, Va.

Additional papers and round-table discussion subject be announced in the August issue of *Tappi*.

Pulp and Paper Manufacture, Vol. III

Volume III, "Pulp and Paper Manufacture," is expected to be available at the time that this issue of *Tappi* goes to press. The text covers manufacture and testing of paper and board. Following are the principal chapter titles:

Chapter 1. Papermaking Machines
- Part 1. Auxiliary Apparatus and Operations Preliminary to Paper Machines
- Part 2. The Fourdrinier Section
- Part 3. The Press Part
- Part 4. Cylinder Machines, Vats, and Presses
- Part 5. The Drier Part
- Part 6. Calenders, Slitters, and Winders
- Part 7. The Paper-Machine Drive
- Part 8. Specialty Papermaking Machines
- Part 9. Paper-Production Calculations

Chapter 2. Handmade Papers
Chapter 3. Finishing of Paper
Chapter 4. Coated Papers
- Part 1. The Coating Process
- Part 2. Gummed Papers
- Part 3. Waxed and Lacquer-Coated Papers

Chapter 5. Paper Testing
- Part 1. Physical Tests
- Part 2. Microscopy of Paper
- Part 3. Chemical Tests

Bibliography

Advance orders for Volume III may be placed with the Book Department, Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York 17, N. Y., at $11 per copy.

Measurement and Control Conference

The Measurement and Control Conference which was held at the Hotel Carter, Cleveland, Ohio, May 21 and 22, 1953, was sponsored by the Lake Erie Section of the Technical Association of Pulp and Paper Industry in cooperation with the Engineering Division of TAPPI, and the Cleveland Sections of The Instrument Society of America and The American Society for Quality Control.

Following the theme "Measurement and Control of Paper and Paperboard Manufacture and Conversion—Present and Future," L. A. Moore of The Black-Clawson Co. introduced the speakers and acted as moderator during the discussion periods. The papers which are summarized in this report will appear in full in an early issue of *Tappi*.

The first paper on the program, "Some Practical Applications of Measurement and Control Instruments in a Paper Mill," was prepared by Ralph W. Peters and Bruce W. Huston of the Eastman Kodak Co., who stated that with a little ingenuity and imagination, standard measurement and control instruments can be adapted to perform many jobs in a paper mill. These are measuring water to individual tanks or to a battery of make-up tanks in a batch operation; distributing stock to different chests; controlling levels in pump boxes, pits, and size tubs; unique applications of chemical make-up and measuring and furnishing sizing chemicals to stock in a batch operation; consistency and stock gate control; automatic jordan shutdown protection; press and calender loading; and drying control.

Next William H. Aiken, Gardner Board and Carton Co., presented "What the Papermaker and Converter Would Like to See Measured and Controlled." Mr. Aiken introduced his subject by expressing the desire for the day when papermaking would be approached as a science rather than an art. An instrumentation program can be most successful with those that think in terms of cause and effect. It must also have the acceptance of both management and labor if it is to succeed. It is probable that the paper and converting industries have not made full use of the instruments available to them and a few suggestions are made where these may be applied. It is also suggested that some instruments could be improved to measure specific properties.

"Instrumentation from Management's Viewpoint," by S. C. Lloyd, Jr., of E. I. du Pont was the last paper of the morning. Management in most modern industrial concerns has come to recognize instrumentation as a vital part of their plant equipment. It is as important as any other piece of equipment and not just an incidental extra. Its uses are rapidly expanding and offer excellent returns in safety, quality, efficiency, and production. Management also recognizes that it must develop the necessary personnel to insure that the instrument investment is wisely made and maintained in a reliable manner with a minimum outage.

After luncheon, H. O. Ehrisman, the Foxboro Co., spoke on "The Instrument Manufacturer's Problems in Meeting the Demands of the Papermaking and Converting Industries." After citing the opportunities as well as some of the difficulties in paper mill instrumentation, Mr. Ehrisman indicated that the instrument manufacturer's everyday problems in meeting the demands of the paper industry are no different than those he encounters in other industries. His fundamental problem, which underlies all his efforts to serve all his customers, is the problem of education in the value of instrumentation.

"Instrumentation Used in Other Industries Which Might Be Applied to Paper Manufacture" was presented by John R. Green, Minneapolis-Honeywell Regulator Co. This paper reviewed some of the presently available industrial instruments and control systems which are applicable to the processes met in the beneficiation of minerals since these processes are somewhat similar to papermaking. It also considered control-system engineering as experienced in other industries.

Irving Lefkowitz of the Case Institute of Technology, described some of the aspects of the instrumentation work done at the distillery plants of Joseph E. Seagram & Sons, Inc., with which he was formerly associated. In his paper, "Other Industry Experience in Measurement and Control Which May be of Benefit to the Paper Industry," the distilling processes and control installations were described in some detail to point out the application of certain principles which should have universal application.

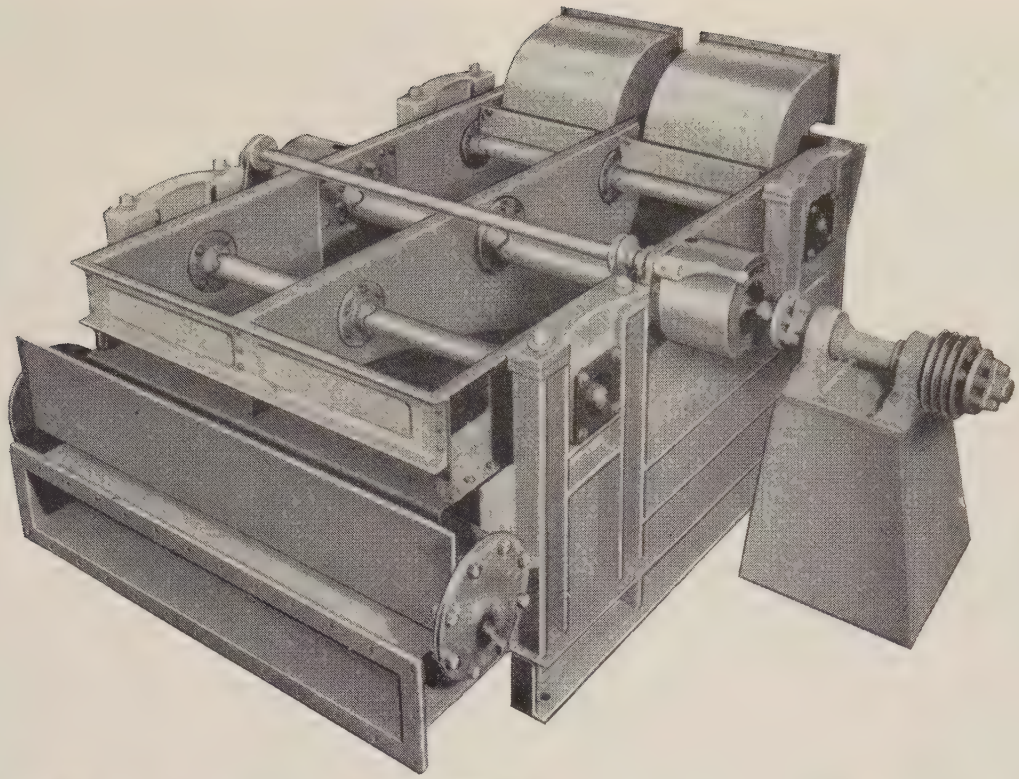
"A Quality Control Program," by John F. Langmaid, Jr., S. D. Warren Co., was the last formal paper on the program. He mentioned that there are two kinds of quality control programs which may be set up: (1) the inspection of the product after it is made to determine whether the product is acceptable or must be rejected or (2) control of the product as it is being made. Variability is the basic reason for setting of a control system, and Mr. Langmaid described the system in use in their plant and indicated their application of data accumulated.

The after-dinner speaker, H. A. Black of the Mead Corp., spoke on "The Human Being—The Most Difficult Measurement and Control Problem of All." Mr. Black cited the methods by which personnel are selected: employee evaluation, personal interview, job analysis, attitude measurement, and field training. However, industry has failed to establish an effective method of human communication and has not been able to solve satisfactorily the difficult field of labor relations. The problem submitted to the technician was that as much effort should be made to work out the human equations as is placed on equipment and process.

On Friday, May 22, there were group visits to the Republic Steel Co. and to the refinery of the Standard Oil Co. of Ohio.

During the duration of the meeting a number of exhibits were set up by the control instrument suppliers. These included:

Bailey Meter Co., Cleveland, Ohio
Bailey Pyrotron temperature indicator-recorder of the electronic type, measurement of temperatures for all service up to and including 1200°F.



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Six hundred Bird Jonsson Screens are now on the job in North American mills

Why this remarkable record of widespread adoption in the relatively short time since Jonsson Screens were introduced in this Country? You'll find the answer in the performance facts and figures as they apply to *your* knotting, coarse screening, straw stock or old paper stock screening operations.

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BIRD MACHINE COMPANY

SOUTH WALPOLE • MASSACHUSETTS

Bailey Mini-line pneumatic controls for control of flow level, pressure, and temperature.

Bailey Mini-line multipointer-type receiver gages used as direct reading gages and receiver indicators with pneumatic transmitters.

Bristol Co., Waterbury, Conn.

Brown Instrument Div., Minneapolis-Honeywell Regulator Co., Cleveland, Ohio

Multiple point Electronik potentiometer for measuring temperature, speed, pH, forces, pressure, and other variables.

Single point Electronik potentiometer for measuring the same variables.

Recording and integrating electric flowmeter for steam, water, air, or gas measurement, mercury type.

Differential convertor pneumatic flow transmitter, mercury less type, for steam, water, air, and so forth.

Diaphragm control valve.

Cleveland Pneumatic Tool Co., Cleveland, Ohio

Aerol lift.

Fischer & Porter Co., Hatboro, Pa.

Resotronic analyzer for rapid indication of the consistency of pulp samples in the range from water up to 2% consistency.

Ratogate control valve for automatically controlling the flow of pulp and other slurries.

Feedrator chemical feeder for controlled addition of small amounts of reagents to main liquid streams.

New design series 1600 ratio control instrument for automatically maintaining desired ratio of flow between two fluid streams.

Series 1600 four-pen recording instrument for two temperature and two pressure receiving elements.

Foxboro Co., Foxboro, Mass.

Multirecord electronic Dynalog recorder for use with thermocouples, resistance thermometer bulbs, load cell, etc.

Differential pressure cell transmitter with packaged piping set for transmitting flow, liquid level, etc.

Model 40 Stabilog controller for controlling temperature, pressure, liquid level, flow, etc.

Rotax electric controller for electric control or alarms of temperature, pressure, liquid level, flow, etc., instruments.

Vernier Valactor for positive positioning of control valves.

General Electric Co., Cleveland, Ohio

Differential voltage indicator. Paper Tensiometer.

W. & L. E. Gurley, Troy, N. Y.

Gurley high-pressure densometer for use on less permeable papers where lengthy tests are prohibitive.

Gurley stiffness tester, wide range, versatile instrument to test stiffness of sheet material for manufacturing control, chemical treatments, textile testing, and research.

Gurley-Hill S-P-S tester—versatile, instrument for testing smoothness, porosity, and softness of sheet material and printing quality of paper. Conforms to TAPPI Suggested Method T 479 sm-48.

Gurley-Cobb sizing tester—testing water absorptiveness of nonbibulous papers and paperboard. Conforms to TAPPI Standard T 441 m-45.

Gurley permeometer—testing porosity or air permeability of very porous materials such as filter and tissue papers, paper and cloth felts, etc. Conforms to ASTM Method D 737–46.

Special reticle display—precision scales, patterns, graduated dials, photoengraved reticles, divided linear and circular scales. Used in optical, electrical, photographic, and other instrument fields.

Hart Moisture Meters, New York, N. Y.

Hart moisture meter.

Hygrotesters, Inc., Brooklyn, N. Y.

Hygrotester—testing and regulating equipment for testing, registering, and fully automatic regulating of moisture, basis weight, and thickness of all types of cardboard, paper, and pulp machines, from thinnest paper to thickest cardboard, at any speed of machine.

Industrial Nucleonics Corp., Columbus, Ohio

Portable engineering survey kit—to demonstrate the applicability of the AccuRay beta gage to the measurement of basis weight.

Totalizer—to demonstrate that the amount of off-specification on-specification material could be registered on counters, continuously and accurately, permitting frequency distribution curves to be obtained quickly for any period of time.

Automatic controller—to demonstrate the ease and feasibility of controlling a process through the use of AccuRay beta gages and associated controllers.

Trace simulator—to demonstrate a typical AccuRay beta gage trace, with and without automatic control of the process.

Panellet, Inc., Chicago, Ill.

"50" Panalarm annunciators.

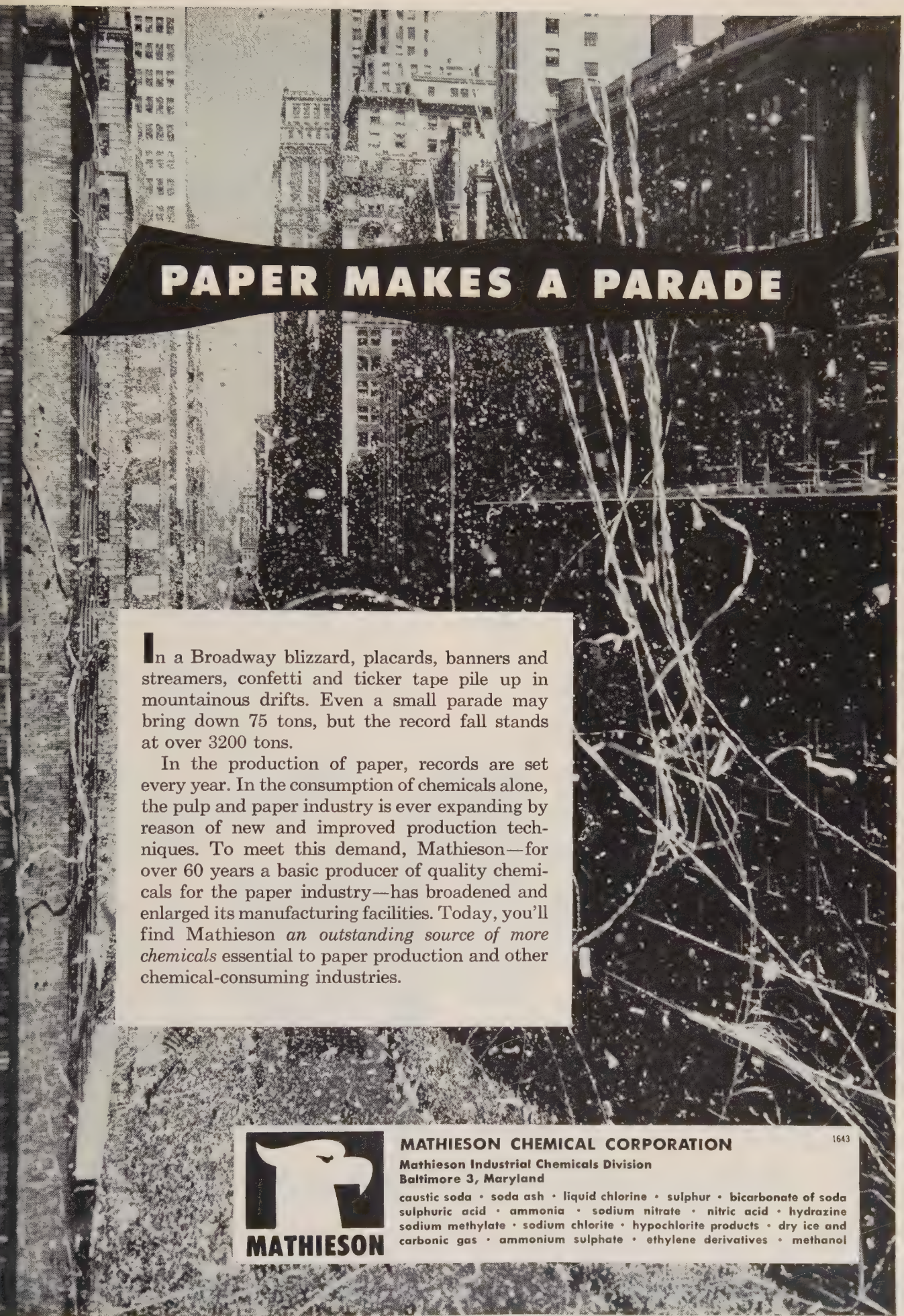
Panellet instrument panel.

Shartle Bros. Machine Div., The Black-Clawson Co., Middletown, Ohio

A regular commercial size mechanical Duotrol unit was mounted to a vertical board containing a mock-up model of a jordan or refiner plug. Electrical activation of the Duotrol caused the plug to move laterally in or out of the conical shell of the jordan or refiner.

A regular sized control panel housing the electrical Duotrol

The Measurement and Control Conference dinner, Cleveland, Ohio, May 21, 1953



In a Broadway blizzard, placards, banners and streamers, confetti and ticker tape pile up in mountainous drifts. Even a small parade may bring down 75 tons, but the record fall stands at over 3200 tons.

In the production of paper, records are set every year. In the consumption of chemicals alone, the pulp and paper industry is ever expanding by reason of new and improved production techniques. To meet this demand, Mathieson—for over 60 years a basic producer of quality chemicals for the paper industry—has broadened and enlarged its manufacturing facilities. Today, you'll find Mathieson *an outstanding source of more chemicals* essential to paper production and other chemical-consuming industries.

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sulphuric acid • ammonia • sodium nitrate • nitric acid • hydrazine
sodium methylate • sodium chlorite • hypochlorite products • dry ice and
carbonic gas • ammonium sulphate • ethylene derivatives • methanol

provided the means for automatically controlling the action of the mechanical Duotrol.

The Swartwout Co., Cleveland, Ohio
Autronic electronic controller.
Autronic electronic recorder.
Autronic electronic manual control.
Autronic electronic power relay.
Autronic electronic differential pressure transmitter.
Autronic electronic pressure transmitter.
Autronic electronic temperature transmitter.

Thwing-Albert Instrument Co., Philadelphia, Pa.
The new Thwing-Albert Model 49RC electro-hydraulic tensile strength tester featuring electrical controls. This instrument is capable of testing from 1 gram to 2000 lb. It has both automatic extension and load cycling and pulling speeds from 0.1 to 20 in. per min. which are infinitely adjustable.

Thwing-Albert Clark zero span grips built to James d'A. Clark's specifications for testing strips 15 mm. in width. These grips are in accordance with TAPPI Suggested Method T 481 sm-52.

The new Thwing-Albert Handle-o-meter which is a new method of testing the softness of tissues. This instrument was developed at the Johnson & Johnson Laboratories.

The Thwing-Albert JDC precision sample cutter which can be supplied to cut strips in widths of 15 mm., 1/2 and 1 in. in width by 10 in. long.

Thwing-Albert Elmendorf tearing tester complete with the Bureau of Standards augmenting attachment for doubling its capacity. This instrument is an official standard of TAPPI T 414 m-42 and it has been adapted by the ASTM standard designation D 689.

Clark softness-stiffness tester which is widely used for determining the rigidity, stiffness, and softness of paper. This instrument was designed by James d'A. Clark.

Tracerlab, Inc., Boston, Mass.
Beta gages for measurement of basis weight of paper and coating.

The Measurement and Control Conference was organized with the assistance of the following:

Lake Erie Section of TAPPI: Wm. Schoenberg, D. E. Shotwell, R. L. Lewis, Jack Means, Ed. F. Burke, and S. B. Gulliford.
American Society for Quality Control: John Warner.
Instrument Society of America: R. J. Carleton and Frank Kirk.
Measurement and Control Conference Committee: J. W. Noll, general chairman, Art Sheely, general vice-chairman, and L. K. Burnett.
Plant Visitations: R. C. Berger, chairman, M. E. Cornman, J. W. Kenny, Ken Kennedy, W. W. Metzner, and L. M. Upholz.
Exhibits: George Gard, chairman, A. A. Aaron, W. F. Fryburg James W. Jacoby, and H. G. Nelson.
House and Arrangements: Ed. F. Burke, chairman, and Ed. S. Furlong, vice-chairman.
Registration: S. B. Guiliford, chairman, Russell C. Brooks, O. M. Cornell, G. G. Halvorsen, Russell Heatherneck, Jalmes Kudena, and Marshall Veigel.
Hospitality: Wm. Foll, chairman, Chas. Daggett, Robt. J. Lee, and Lloyd Shand.
Publicity: Russ Lewis, chairman.

Fourth Coating Conference

The Fourth Coating Conference of the Technical Association of the Pulp and Paper Industry was held at the Netherland Plaza Hotel, Cincinnati, Ohio, on May 25–27, 1953. The attendance was about 350 individuals. John H. Heuer of the Great Northern Paper Co., Millinocket, Me., is chairman of the TAPPI Coating Committee. Richard T. Trelfa of the Watervliet Paper Co., Watervliet, Mich., was in charge of the technical programs.

Since the papers presented will be published in full in a future issue of *Tappi* they will be summarized briefly in this general account.

Arrangements

The conference was jointly sponsored by the TAPPI Coating Committee and the Ohio Section, C. E. Brandon, Howard Paper Mills, Inc., Dayton, Ohio, chairman. Details concerning the local arrangements were handled by the Section. George B. Gregg of the Cincinnati Gas & Electric Co., Cincinnati, was in general charge of arrangements.

Associated with Mr. Gregg were Paul Miller of the Herbert Chemical Co., Cincinnati, in charge of transportation; Stanley MacLaren of Penick & Ford, Inc., Cincinnati, was in charge of registration. Other members of the Arrangements Committee included: W. P. Conant, Monsanto Chemical Co., Cincinnati; H. E. Cramer, Gardner Board & Carton Co., Lockland; Charles F. King, U. S. Printing & Lithograph Co., Norwood; John D. Davis, Mead Corp., Chillicothe; R. C. Grimm, Stein, Hall & Co., Cincinnati; Lou Hackley, Champion Paper & Fibre Co., Hamilton, and Charles Sweitzer, Gardner Board & Carton Co., Middletown.

Technical Symposia

The technical program featured two symposia and a general session. A. C. Zettlemoyer of the National Printing Ink Research Institute, Lehigh University, Bethlehem, Pa., was Chairman of a symposium and panel discussion on "Coated Paper in Offset Printing." Joseph T. Loomer of Robert Gair Co., Uncasville, Conn., was chairman of a symposium and panel discussion on "Coated Board." Richard T. Trelfa was chairman of the final session devoted to miscellaneous papers relating to coating.

Plant Visits

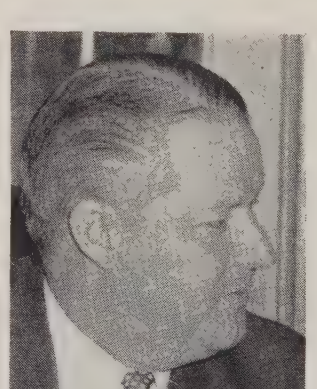
The conference was featured on Wednesday, May 27, by inspection tours of the plants of Gardner Board & Carton Co. at Lockland, Ohio, where the group saw the two fabrication plants and 132-in. paperboard machine equipped with a Consolidated coater. Nearly all of the board made at Lockland is printed in one to four colors on two rotary gravure presses.

Several individuals visited the plant of the U. S. Printing and Lithograph Co. at Norwood where they saw a number of very interesting printing operations.

The group who visited the mills of the Mead Corp. at Chillicothe, Ohio, had to sacrifice listening to the papers presented on Wednesday and took an early train to Chillicothe, Ohio, where they saw the many papermaking and coating operations as well as the remarkable new Mead Corp. research laboratory. The group were guests of the Mead Corp. at luncheon.

Luncheon Program

The Coating Conferences have each featured addresses by leaders of the paper industry. Benton R. Cancell, the vice-president of the St. Regis Paper Co., Deferiet, N. Y., now with the Rhinelander Paper Co., was the speaker at the Grand Rapids conference. George Olmsted, president of the S. D. Warren Co., Cumberland Mills, Me., was the speaker at the Boston conference. Peter J. Massey, pioneer in machine coating and now a consultant in Chicago, was the featured speaker at last year's Chicago conference.



Reuben B. Robertson, Jr., Champion Paper & Fibre Co.

This year the conference was honored by an address by Reuben B. Robertson, Jr., president of the Champion Paper & Fiber Co., Hamilton, Ohio, who gave an interesting account of his visit to Western Germany as a member of a Mutual Security Agency mission to study business conditions and the advances made in German industry.

R. G. Macdonald was toastmaster and introduced the individuals seated at the head table including George H.

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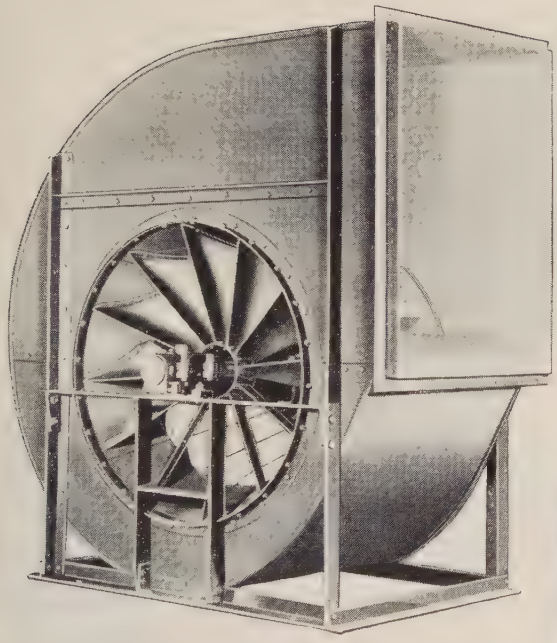

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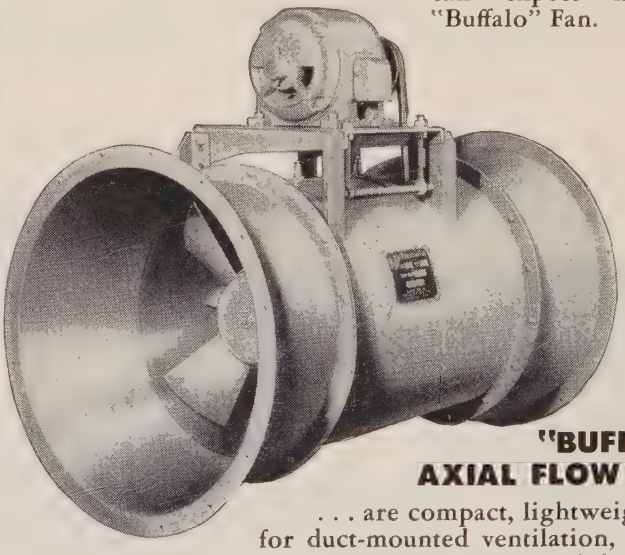

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Pringle, president of the Association, J. H. Heuer, chairman of the Coating Committee, and Richard Trelfa the new chairman of the committee.

Offset Printing of Coated Paper

On Monday, May 25, the entire technical program was devoted to a consideration of "Coated Paper in Offset Printing" with A. C. Zettlemoyer of the National Printing Ink Research Institute, Bethlehem, Pa., presiding as chairman.

A. P. Reynolds and F. H. Frost of the S. D. Warren Co., Cumberland Mills, Me., presented a two-part paper on "Coated Paper and Offset Printing." When coated two-sides papers were first introduced in the middle thirties, lithographers found these papers rather difficult to run than wove papers. The reasons involved problems relating to ink, fountain solution, blankets, plate grain, halftones, and press adjustments. Ways in which these problems were met were cited by Dr. Frost.

"Offset Inks for Coated Papers" was the subject of the next talk which was given by F. S. Dankert of the Sun Chemical Co., East Rutherford, N. J. The surface problems of coated paper in relation to lithographic inks is dependent upon the viscosity of offset inks. The viscosity of an ink, in general terms, is its body, tack, and flow properties. A lithographic ink has to have certain characteristics of body to resist the fountain solutions used on the plate. It must at the same time have enough greasiness to be receptive to the image and have certain flow properties to carry or distribute on the roller. To this extent, the properties of lithographic inks with regard to their particular construction and the problems in relation to a coated paper were discussed by Mr. Dankert.

Charles F. King, U. S. Printing & Lithographic Co., Cincinnati, Ohio, was last on the morning program with his discussion "Offset Printing on Coating Papers." Mr. King outlined the difficulties which were, and still are, encountered in the development of the lithographic process. Many of the problems are obscured by the complexity of the factors involved. As far as paper is concerned, although most of the previously recognized properties needed in a good offset are important, that of wettability of the surface by ink rather than the absorption of ink into the stock is extremely important. Up to this point most improvements in wettability have been made by the inkmakers, but it appears that improved wettability could be incorporated into the coating itself.

C. F. King, U. S. Printing & Lithographic Co.; J. D. Davis, Mead Corp.; R. T. Trelfa, Watervliet Paper Co.; and G. H. Pringle, Mead Corp.

After lunch, the meeting continued with a presentation by David W. S. Riddell of The Montreal Lithographing Co., "Non-Paper Factors and Quality of Offset Lithographing."

With the introduction of the high-speed rotary offset litho press, and its accompanying mass production techniques, the need for precise scientific control of all steps in the lithographic process has been recognized.

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W. P. Conant, Jr., Monsanto Chemical Co.; S. F. MacLaren, Penick & Ford, Ltd.; and Charles Switzer, Gardner Board & Carton Co.

Mr. Riddell discussed some of the major variables encountered in camera, plate making, and press operations. Plate making and press factors were specifically covered, and instrumentation as an aid toward controlling variables.

"Operating Factors in Offset Printing on Coated Papers" by Robert F. Reed and Gordon Wheeler of Lithographic Technical Foundation, was the last paper on Monday's program.

Offset printing on coated papers requires a high degree of perfection and precision in press operation. Press conditions that permit passable printing on uncoated papers will often result in unsatisfactory printing on coated papers. Printing pressures, uniformity in thickness of plates, blankets and packing, and constant angular velocities of cylinders are most important.

Scumming and tinting are always more pronounced on coated than on uncoated papers because the higher contrast makes them more visible. It is important, therefore, that well-desensitized printing plates be used. Great improvements in plates have recently been made that help in the printing of coated stocks.

Press fountains solutions usually contain low concentrations of phosphates plus bichromate and/or nitrate, and gum arabic or cellulose gum. The functions of these materials in keeping the plate clean during printing are little understood, and research on them is difficult. Side effects of the fountain water include curl and dimensional changes in the paper, emulsification of water in the ink, and retarded drying of the printed sheets. Research has been directed toward reduction of the amount of dampening water required, with considerable success. Further work is needed to find fountain water constituents that not only preserve the printing properties of the plate, but that have less detrimental effects on ink drying.

These papers were followed by a panel discussion on the factors involved in offset printing of coated papers.

Coated Board

The Tuesday program was devoted to a symposium on coated board with Joseph T. Loomer of the Robert Gair Co. acting as chairman. Mr. Loomer introduced R. Padevic who read "Experience with the Champion Machine Coater on a Board Machine" that was written by Glenn Renegar of the Container Corp. of America. Mr. Renegar's paper described the coating equipment which was installed in the Philadelphia plant of the Container Corp. as well as the basic steps in producing the board to which the coating is applied. He then outlined those factors which affect both the coating and subsequent converting operations.

Next on the program, Harry C. Fisher, Gardner Board & Carton Co. presented his paper, "The Role of Calendering in the Machine Coating of Paper." The qualities of the board and the coated board as they relate to the calendering operation and use requirements were cited. The action of the calender was then discussed on the basis of the evaluation of the quality of printing on the coated board.

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In "Considerations in the Installation of High and Low Solids Machine Coaters on a Paperboard Machine," A. W. Pomper of the John Waldron Corp. presented theoretical and practical concepts on board machine coating with two different methods. The Microjet is a low solids coater operating on the principle of controlled removal of coating. The Syncroset is a high solids coater operating on the metered application principle.

The Microjet method begins with application of a slight excess of coating by means of a roll rotating in a supply pan, at a controlled rate of speed. The excess coating is removed with a high velocity jet of air impinging on the surface of the web, metering and smoothing the coating remaining on the web. Coating weight depends primarily on viscosity and on the velocity of the air jet.

The Syncroset consists of a furnish roll rotating in a pan, supplying coating to an engraved roll. The coating is transferred from the engraving to a rubber offset roll, and to the web against a steel backing roll. Dry weight is determined by the depth and pattern of the engraving and by the percentage solids.

Both types of coaters are installed near the dry end of the machine since it is important that the coated surface be sufficiently dry to prevent picking off on the drying drums. The Microjet requires some air drying before the surface passes around a drying drum, in all cases. Due to its ability to coat at up to 65% solids as contrasted with the 45% solids maximum of the Microjet, the Syncroset may not require air drying at lower speeds. In high-speed installations, however, some air drying is required, although considerably less than with the Microjet.

The Coating Conference Luncheon was held Tuesday noon, May 26, and was featured by an address from Reuben B. Robertson, Jr., president of the Champion Paper & Fibre Co.

Tuesday afternoon's session was introduced with a paper by Osborn M. Curtis, Jr., of the Lord Baltimore Press, "Customer Requirements in Coated Boxboard," that outlined the problems of the printer and the properties of the sheet that are desired. The requirements in coated boxboard are for level surface which will permit high-speed multicolor reproduction. The demand, so far as the finished container is concerned, lies in the direction of bright colors and clear sparkling reproduction.

This paper was followed by a panel discussion on the machine coating of board.

General Session

A General Session was held Wednesday morning. R. J. Jacobs, Dilts Machine Works, presented the first paper "Consideration in the Design of a Universal Coating Machine for Paper and Board." Current interest in coating machinery indicates a trend wherein extreme versatility is desired in order to handle a wide range of coating materials and webs. This trend has been stimulated by the increased usage of specific coating formulations to improve paper products for specific applications. To meet this requirement, special considerations are required in the design and construction of the coating unit and auxiliary equipment. By a series of diagrams, it was shown how a single coater can be designed to perform most roll coating, air knife, hot melt, gravure, reverse, kiss, and offset operations, by addition or subtraction of various elements in the same frame, and utilizing the same unwinds, oven, cooling section, and winder. Conclusions were drawn on the applicability of the universal machine to laboratory work and the limitations in various categories of coating work on commercial machinery.

The second paper was "Pigmented Size Press Coatings Containing Dow Latex 512-K" by L. H. Silvernail and E. J. Heiser, Dow Chemical Co., who gave a progress report on the use of latex in pigmented size press coatings. The effect on the physical properties of using this type of coating as an undercoating for subsequent overcoating was described. It was found that the two-coat system produced a superior printing enamel to the conventional one-coat off-machine application. This superiority showed up as increased body stock picking resistance, increased coating picking resistance, and increased folding strength. These improvements were demonstrated at approximately the same over-all cost. Marked improvement in quality and savings in costs are realized through the use of size press coatings containing latex as a precoat for clear lacquer and clear latex overcoatings. The use of latex size press coated paper as a printing paper was also discussed.

A simple optical instrument for the evaluation of coated paper smoothness was the subject of the paper "An Approach to the Evaluation of Coated Paper Smoothness" by Louis J. Scheid and Arthur H. Hupp, of the Watervliet Paper Co. Test reproducibility compares favorably with that of the Bekk smoothness tester and with the papers tested the smoothness values obtained show excellent correlation with visual ranking of surface smoothness.

The instrument consists of a binocular microscope and a source of parallel light beams mounted on a hinged lever which can be rotated through a 90° arc. Surface to be tested is placed on the binocular microscope at the point of intersection of the axes of light beam, optical field, and rotation. Light source is raised through an arc until appropriate end point is determined through observation of changes of light and shadow on the surface through the microscope.

The last paper was "A Progress Report on the Development of Calcium Carbonates for High Gloss Coating" by Robert Hazenmeyer and G. E. Hall of the Wyandotte Chemical Co.

As previously mentioned these papers will be published in an early issue of *Tappi*.

PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

William C. Baggs, Mill Manager, Bathurst Power & Paper Co. Ltd., Bathurst, N. S., Canada, a 1936 graduate of McGill University.

John R. Beamish, Assistant Chief Chemist, Gair Co. (Canada) Ltd., Toronto, Ont., Canada, a 1940 graduate of the University of New Brunswick.

Herbert W. Beck, Sales Manager, Morden Machines Co., Portland, Ore., a 1941 graduate of Brooklyn Polytechnic Institute.

Weston T. Bennett, Chief Engineer, Canadian International Paper Co., Montreal, P. Q., Canada, a 1924 graduate of Tufts College.

Grafton H. Berry, Production Manager, Daniels Mfg. Co., Rhinelander, Wis., a 1934 graduate of the University of Wisconsin.

Donald F. Best, Manager of Manufacturing, the KVP Co. Ltd., Espanola, Ont., Canada, a 1937 graduate of the University of Manitoba.

Howard Bidwell, Plant Engineer, Brightwater Paper Co., Adams, Mass.

Lewis W. Blight, Technical Representative, Electrochemicals Dept., E. I. du Pont de Nemours & Co., Inc., Niagara Falls, N. Y., a 1951 graduate of Pennsylvania State College.

Raymond Boucher, Mill Chemist, Canadian International Paper Co., Hawkesbury, Ont., Canada, a 1928 graduate of Laval University, Quebec.

Harold W. Buck, Research Physicist, Oxford Paper Co., Rumford, Me., a 1952 graduate of the University of Maine.

Wesley S. Corbin, Chief Engineer, The Bagley & Sewall Co., Watertown, N. Y., a 1931 graduate of Cornell University.

Frank R. Coughlin, President, Coughlin Mfg. Co., New York, N. Y.

William B. Cranford, Research Engineer, Industrial Cellulose Research Ltd., Hawkesbury, Ont., Canada, a 1942 graduate of the University of Toronto.

Anthony J. DeCillis, Technical Representative, Continental Oil Co., Chicago, Ill., a 1948 graduate of Pennsylvania State College.

Maurice Delaveau, Engineer, Cartonneries de La Rochette, Paris, France, a 1949 graduate of the Electrochemical Institute, Grenoble.

Richard M. Donahue, Plant Manager, Wisconsin Fibre Products Plant, Line Materials Co., Barton, Wis., a 1934 graduate of the University of Vermont.

Robert R. Edwards, Resident Manager and Vice-President, Pacific Mills Ltd., Ocean Falls, B. C., Canada, a 1936 graduate of the University of Saskatchewan.

Richard L. Elderkin, Junior Mechanical Engineer, Abitibi Power & Paper Co. Ltd., Sault Ste. Marie, Ont., Canada, a 1952 graduate of McGill University.

Abraham Emmer, Plant Engineer, Standard Corrugated Case Corp., Ridgefield, N. J., a 1938 graduate of the College of the City of New York.

Rodger L. Fife, Quality Control Supervisor, Krafco Container Corp., West Monroe, La., a 1950 graduate of Fenn College.

Aaron H. Fink, President, Essex Paper Box Mfg. Co., Inc., Newark, N. J., a 1938 graduate of Johns Hopkins University.

Hugh W. Flynn, Northwest Representative, Stein, Hall & Co., Inc., New York, N. Y., a 1949 graduate of the University of Oregon.

Joseph Forgacs, Director, Anglo-Continental Pulp & Paper Trading Co. Ltd., London, England.

Hans V. Friberg, Research Manager, Swedish Cellulose Co., Sundsbruk, Sweden, a 1940 graduate of Royal Technical University.

Maurice Gerin, Forest Engineer and General Manager, Station Forestiere, Duchesnay, Cte. Portneuf, P. Q., Canada, a 1935 graduate of Laval University.

Lester C. Greenwald, Foreman, Stores Div., Egry Register Co., Dayton, Ohio, a 1952 graduate of Sinclair College.

J. Roderick Henderson, Controller, Wolvercote Paper Mill, Wolvercote, Oxford, England.

Gerald I. Hermanson, Vice-President, Technical Papers Corp., Boston, Mass., a 1948 graduate of the University of Maine.

Francis J. Higgins, Associate Research Chemist, Continental Oil Co., Ponca City, Okla, a 1939 graduate of The Creighton University.

Edward F. Hudson, Development Chemist, Lowe Paper Co., Ridgefield, N. J., a 1949 graduate of Brookyln Polytechnic Institute.

Gary W. Jones, Technical Supervisor, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., a 1941 graduate of Oberlin College, with a Ph.D. degree from The Institute of Paper Chemistry in 1949.

Wilbur B. Keller, Chief Inspector, Champion Paper & Fibre Co., Hamilton, Ohio.

Malcolm Kimmelmann, Plant Manager, Oneida Paper Products, Inc., Clifton, N. J. Attended Brooklyn Polytechnic Institute and New York University.

Samuel B. Knapp, Chemical Engineer, Hawaiian Sugar Planters' Association, Honolulu, T. H., a 1947 graduate of Louisiana State University.

Joseph V. Kopycinski, Librarian, Lowell Technological Institute of Massachusetts, Lowell, Mass., a 1950 graduate of Lowell Textile Institute.

Robert H. Lace, Technical Director, Lincoln Paper Co., Chicago, Ill., a 1937 graduate of Illinois Institute of Technology.

Keith E. Lachance, Technical Assistant to Manager of Specialty Mills, The E. B. Eddy Co., Hull, P. Q., Canada, a 1947 graduate of Queen's University.

Carl E. Lauer, Chief Chemist, The Texas Co., Port Arthur, Tex., a 1914 graduate of the University of Kentucky.

Carl M. Leeds, President, Leeds Sales Co., Paper Div., New York, N. Y., a 1932 graduate of the New York Maritime Academy.

David M. Lieberwitz, Sales Manager, Arch Built Corrugated Products Corp., Maspeth, N. Y.

Claude Limondin, Assistant Director General, Cellulose du Rhone, Paris, France. Attended the Polytechnique College, Paris.

Burdell L. Lower, Chemical Engineer, The Northwest Paper Co., Cloquet, Minn., a 1950 graduate of the University of Nebraska.

A. Murl Miller, Technical Director, Coos Bay Pulp Corp., Empire, Ore., a 1938 graduate of Whitman College.

Bertil Nybergh, Managing Director, Research Institute of the Finnish Pulp & Paper Industries, Helsinki, Finland, a

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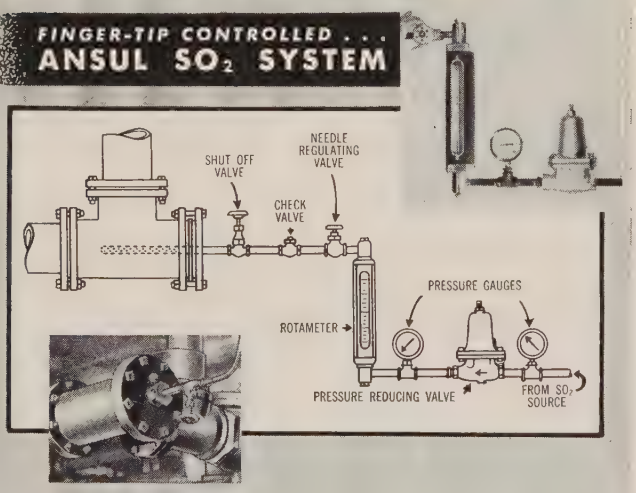

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1921 graduate of Helsingfors University with a Ph.D. degree.

Thomas W. Oliver, Power Plant Superintendent, Container Corp. of America, Fernandina Beach, Fla. Attended Georgia School of Technology.

Melvin W. Olson, Assistant Chief Engineer, Everett Pulp & Paper Co., Everett, Wash., a 1936 graduate of the University of Minnesota.

Arthur C. Proffitt, Student, University of Cincinnati, Cincinnati, Ohio, graduating in June, 1953.

Richard D. Rheutan, President, Union Envelope Co., Richmond, Va. Attended the University of Virginia.

Victor J. Rick, Plant Engineer, Portco Corp., Paper Products Div., Vancouver, Wash., a 1949 graduate of Oregon State College.

Charles O. Roth, Jr., Sales Engineer, Hinde & Dauch Paper Co., Sandusky, Ohio, a 1925 graduate of the University of Delaware.

Frank E. Safino, Jr., Chemist, Lowe Paper Co., Ridgefield, N. J., a 1950 graduate of Seton Hall University.

John G. Senese, Jr., Chemical Engineer, American Cyanamid Co., Valdosta, Ga., a 1950 graduate of the Massachusetts Institute of Technology.

P. Sheel, Head, Indian National Scientific Documentation Centre, National Physical Laboratory, New Delhi, India.

Luiz T. Simao, Manager, Fabrica de Papel do Almonda Lda., Renova, Torres Novas, Portugal, a 1950 graduate of the University of Porto, Portugal.

Denholm Smith, Pulp Mill Supervisor, St. Regis Paper Co , Pensacola, Fla., a 1938 graduate of Bowdoin College.

Earle C. Smith, Instrument Engineer, Fluid Controls Co., New York, N. Y., a 1942 graduate of the University of Miami.

Rodger O. Smith, General Superintendent, Manistique Pulp & Paper Co., Manistique, Mich.

Neil J. Stalter, Sales Development, Electrochemicals Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., a 1931 graduate of the Rochester Institute of Technology.

Vivian T. Stannett, Assistant Professor of Polymer Chemistry, State University of New York, College of Forestry, Syracuse, N. Y., a 1950 graduate of Brooklyn Institute of Technology.

Thomas R. Stein, Resident Manager, Rayonier, Inc., Jesup, Ga., a 1922 graduate of Bucknell University.

Raymond A. Surveyer, Industrial Engineer, Alton Box Board Co., Alton, Ill., a 1940 graduate of Rensselaer Polytechnic Institute.

Clifford G. Thompson, General Production Manager and Director, Bishop Asphalt Paper Ltd., Portneuf Station, P. Q., Canada. Attended Queens University, Kingston, Ont.

Clifton Towles, Assistant Technical Adviser, Champion Paper & Fibre Co., Hamilton, Ohio, a 1948 graduate of Wilmington College.

Ralph L. Ueberbacher, Supervisor, Customer Service-Research, American Maise Products Co., Roby, Ind., a 1941 graduate of DePaul University.

Marshall A. Veigel, District Manager, National Aluminate Corp., Chicago, Ill., a 1941 graduate of Case Institute of Technology.

Maunsell C. Wakefield, Jr., Salesman, Titanium Pigment Corp., Chicago, Ill., a 1946 graduate of the University of Texas.

William F. Ward, Chief Engineer, F. X. Hooper Co., Inc., Glenarm, Md., a 1940 graduate of Johns Hopkins University.

Kenneth J. Wilson, Statistician, Albert E. Reed & Co. Ltd., Larkfield, Maidstone, Kent, England, a 1948 graduate of the University of London.

Richard E. Wirth, Supervisor, Ball Brothers Co., Inc., Muncie, Ind.

Robert R. Wissinger, Chief Chemist, Frye Mfg. Co., Des Moines, Ia., a 1940 graduate of Kenyon College.

Michael J. Yanulis, Chemist, Lowe Paper Co., Ridgefield, N. J., a 1951 graduate of Erskine College.

Ralph V. Zepp, Assistant Resident Engineer, Rayonier, Inc., Jesup, Ga., a 1948 graduate of the University of Minnesota.

TAPPI Notes

Clyde M. Anderson, formerly of APW Products, Inc., is now Chemist for the Monadnock Paper Mills, Inc., Bennington, N. H.

Harold M. Annis is now Technical Director of The Oxford Paper Co., Rumford, Me.

Paul Atkins, formerly of the Lee Paper Co., is now Assistant Superintendent of the Potlatch Forests, Inc., Pomona, Calif.

John P. Burns is now employed as President by the Burns Piping Supply, Inc., Syracuse, N. Y.

Lloyd M. Carpenter, formerly of the Plymouth Cordage Co., is now Chemist for E. W. Twitchell, Inc., Philadelphia, Pa.

Harold D. Clarke, formerly of the St. Regis Paper Co., is now Mill Sales Representative for J. & J. Rogers Co., Au Sable Forks, N. Y.

Ellsworth J. Cook, formerly of the Paper Corp. of America, is now Senior Chemist for the Kelco Co., Chicago, Ill.

Ralph M. Cook, Jr., formerly of Hollingsworth & Whitney Co., is now Mill Chemist for the Claremont Paper Co., Claremont, N. H.

John B. Davidson, formerly of the Plaskon Div., Libbey-Owens-Ford Glass Co., is now Research Director for the Cowles Chemical Co., Syracuse, N. Y.

G. Robert Donelson, formerly of the Claremont Paper Co., is now Chemist for the Brightwater Paper Co., Adams, Mass.

Axel Ekwall, formerly Mill Manager of Fiskeby-Fabriks A/B, is now with Union Paper Co., Amot, Norway.

Phillips Goldstein, formerly of Bennett, Inc., is now Chief Chemist of George O. Jenkins Co., Bridgewater, Mass.

Raymond E. Green, Chief Electrical Engineer of Raw Electrical Equipment Co., has moved his office to 314 E. 39th St., New York 16, N. Y.

Mace V. Harris is now Vice-President of the Northwest Paper Co., Cloquet, Minn.

Raymond L. Jones, formerly Student at Western Michigan College, is now a Graduate Fellow at The Institute of Paper Chemistry, Appleton, Wis.

David J. Kraske, formerly Student, is now a Research Assistant at Western Michigan College, Kalamazoo, Mich.

E. L. Lamb, formerly of the Oxford Paper Co., is now Director of Research for the Minnesota & Ontario Paper Co., International Falls, Minn.

Clinton W. MacMullen, formerly of the Cowles Chemical Co., is now Section Chief for Olin Industries, New Haven, Conn.

Douglas M. McBean, Consulting Engineer, has moved his office in Rochester, N. Y., to 317 Main St.

Harry L. Mahl, formerly of Gulf States Paper Corp., is now Chemical Engineer for Velsicol Corp., Memphis, Tenn.

Edward A. Mason, Assistant Professor of Chemical Engineering, Massachusetts Institute of Technology, has been transferred from the Eastern Corp. Station to Cambridge, Mass.

Benjamin F. May, formerly of The Gulf States Paper Corp., is now Assistant Plant Superintendent of Borden Co., Chemical Div., Demopolis, Ala.

Edward K. Nissen, formerly of The U. S. Air Force, has returned to the Nekoosa-Edwards Paper Co., Port Edwards, Wis., as a Chemical Engineer.

Davis W. Peat, formerly of The Howard Smith Paper Mills Ltd., is now in the Research Dept. of The Oxford Paper Co., Rumford, Me.

Frank T. Peterson is now Vice-President and in Charge of the New York office of The Black-Clawson Co., 250 Park Ave., New York, N. Y.

Thomas E. Price, formerly of Parsons Paper Co., is now Chemist for C. P. Hall Co., Chicago, Ill.

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ARCCO 1044-31 — Heat Seal Coating for Candy Bar Wraps. Data Sheet C-66.

ARCCO 716-6 — Heat Seal Spot Coating for Waxed Glassine. Data Sheet C-66.

FOILAC 1261-12C — (Clear) Solution Coatings for Metal Foils. Data Sheet C-61-R.

ARCCO 1044-27A — **ARCCO 1044-27B** — Heat Seal Greaseproof Resin Emulsion Coatings. Data Sheet A-43.

ARWAX 717-46B — Hot Melt — paraffin wax additive for improved heat seal and improved water-vapor resistance. Data Sheet C-71.

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Arthur L. Ross is now Vice-President of the Southern Kraft Div., International Paper Co., Mobile, Ala.

John M. Rudolf, formerly of Mertecfelt Corp., is now Sales Manager of Papermaking Equipment Co., Englewood, N. J.

George E. Scofield is now Assistant Resident Manager of Rayonier, Inc., Jesup, Ga.

Paul M. Schaffrath is now Director of Research of The Oxford Paper Co., Rumford, Me.

Wyman F. Uhl, formerly of American Coating Mills, is now Chief Chemist of William H. Welsh Co., Chicago, Ill.

Vance V. Vallandigham is now Mill Manager of Potlatch Forests, Inc., Lewiston, Idaho.

Einar Walloe is now Superintendent of MacMillan & Bloedel Ltd., Nanaimo, B. C.

W. Wayne Wheelhouse, formerly of Cupples-Hesse Corp., is now in the Quality Control Dept. of the Sefton Fibre Can Co., St. Louis, Mo.

Robert H. Winter, formerly of McLauren-Jones Co., is now Chemist of Nylco Products, Inc., Clinton, Mass.

Robert H. Woods is now Plant Engineer of the Marathon Corp., Menasha, Wis.

Frank L. Yankoviak, formerly Student of Western Michigan College, is now Project Engineer for Sutherland Paper Co., Kalamazoo, Mich.

Anthony A. Yankowski, formerly of The Coosa River Newsprint Co., is now Groundwood Technologist for Kimberly-Clark Corp., Neenah, Wis.

* * *

J. Yoshitoshi has succeeded *S. Kagesa* as the official corporate representative of the Kokusaku Pulp Co., Asahikaws Hokkaido, Japan.

New TAPPI Corporate Members

The following companies have become corporate members of the Technical Association in 1953:

d'Alizay, Soc. Ind. de Cellulose, Alizay, France.
Corning Fibre Box Co., Corning, N. Y.
Downing Box Co., Milwaukee, Wis.
Glanstoff-Courtaulds G.m.b.H., Koln-Weidenpesch, Germany
Hoague-Sprague Corp., Lynn, Mass.
Lenzinger Zellulose Papierfabric A/G, Lenzing, Austria
Line Material Co., Sherman, Tex.
Menasha Wooden Ware Corp., Menasha, Wis.
Rohtas Industries Ltd., Dalmianagar, India
Royal Container Co., San Francisco, Calif.
Tasman Pulp & Paper Co. Ltd., Auckland, N. Z.

New TAPPI Sustaining Members

The following companies have become sustaining members of the Technical Association in 1953:

Alrose Chemical Co., Providence, R. I.
Appleton Woolen Mills, Appleton, Wis.
Arabol Mfg. Co., New York, N. Y.
Cabot, Godfrey L., Inc., Boston, Mass.
Carpenter Steel Co., Alloy Tube Div., Union, N. J.
General Corrugated Machinery Co., Palisades Park, N. J.
Hygrotester, Inc., Brooklyn, N. Y.
Mixing Equipment Co., Inc., Rochester, N. Y.
Owens-Corning Fiberglas Corp., Newark, Ohio
St. Lawrence Starch Co. Ltd., Port Credit, Ont., Canada
Sandoz Chemical Works, Inc., New York, N. Y.
Sandusky Foundry & Machine Co., Sandusky, Ohio
Semet-Solvay Div., Petrochemical Sales, Allied Chem. & Dye Corp., New York, N. Y.
Swift, George W., Jr., Inc., Bordentown, N. J.
Tidewater Construction Co., Norfolk, Va.

Industry Notes

LOWELL TECH

On Monday, May 25, Governor Christian A. Herter of Massachusetts signed the bill which changes the name of

Norman Scott, Boston Paper Trade Assoc. and the New England Paper Merchants Assoc.; M. J. Lydon, Lowell Textile Institute; T. J. Sargent, C. J. Higgins, and John Lewis, Lowell Textile Institute

Lowell Textile Institute to its new designation, Lowell Technological Institute of Massachusetts. The new name is one which received favorable votes from a large majority of the Institute's trustees, alumni, faculty, and undergraduates when they were polled several months ago.

The new designation is more suitable for the Lowell college, since it implies a greater breadth in the Institute's services than did the former name. Departments of Leather Engineering and Paper Engineering have now become well established at the Institute, and new departments of Electronics and Plastics are in prospect for the near future. All phases of textile chemistry and textile manufacturing, which have earned for the Institute an excellent reputation, will continue to play their important part in the program with no lessening of emphasis on either of these major fields.

President Martin J. Lydon of Lowell Textile Institute announced the awarding of two scholarships to students in the Paper Engineering course. The awards, both carrying a stipend of $150 per year, were given by the Boston Paper Trade Association and the New England Paper Merchants Association through their secretary, Norman Scott, who was present to give the recipients their checks.

Open to New England residents who are members of the upper classes, the scholarships are awarded on a basis of scholastic standing, personality, campus activity, and interest in the paper industry as a career field. Last year the Paper Trade went to Arthur Tournas '54, while the New England Paper Merchants grant went to Lawrence Hince '55.

The recipients this year are Thomas J. Sargent and Charles J. Higgins, both members of the class of 1954 and both residents of Lowell. Both men are majoring in Paper Engineering, and plan to enter the industry upon their graduation from the Institute.

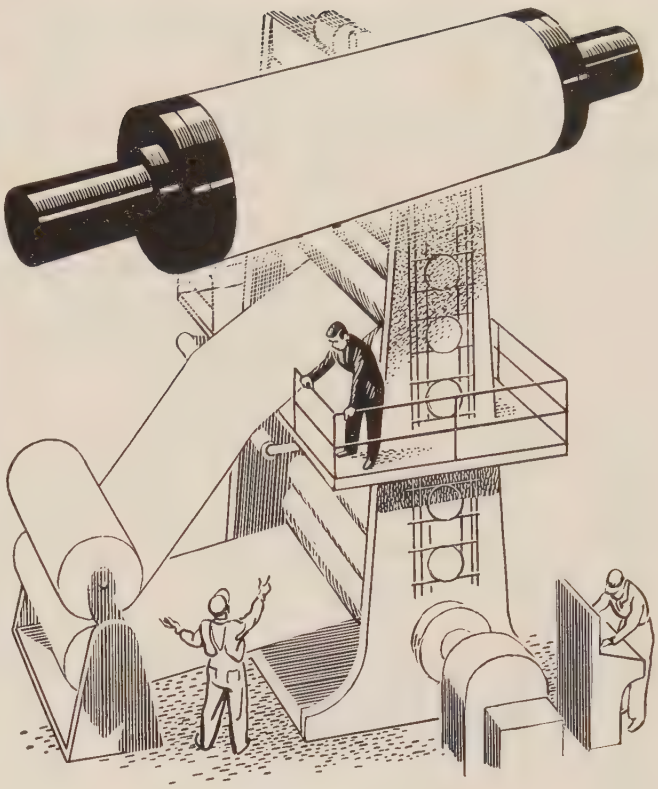
SCOTTISSUE

Scott Paper Co. has made plans to start building a second paper machine on the West Coast, according to Raymond C. Mateer, executive vice-president.

He spoke at cornerstone laying ceremonies to celebrate the construction of the company's first paper machine at its Everett, Wash., site.

Mr. Mateer indicated that the cost of the first machine installation, which includes building and converting equipment, well exceed $16 million.

Scott Vice-President, G. Willing Pepper, introduced the speakers at the corner stone laying ceremonies. They included Everett Mayor, Lewis A. Unzelman, and Scott Assist-



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ant Vice-President, Paul C. Baldwin. Benediction was given by the Reverend Gordon W. Lind of Everett. Guests for the occasion included employees of the Soundview mill and their families as well as citizens of Everett and friends of the company throughout the Pacific Northwest.

Mr. Mateer, together with U. M. Dickey, Scott vice-president and senior member of the Board of Directors on the West Coast, presided jointly at the ceremonies.

Construction of the paper mill was started several months ago directly adjacent to Scott's large bleached sulphite pulp mill. The pulp mill and its substantial timber holdings were operated for years as the Soundview Pulp Co. Until the merger with Scott in 1951, Mr. Dickey served as Soundview president.

Speaking about the plans for another paper machine at the same location, Mr. Mateer said that "if our present plans carry through, this second machine will be installed and operating shortly after the start-up of the first machine in January, 1954."

He spoke enthusiastically about the broadened opportunities provided by the merger with Soundview and of the cordial relations which have been established between the personnel of the two companies.

West Virginia

West Virginia Pulp and Paper Co. will purchase additional timber reserves in North Carolina as a result of a transaction just completed with Richmond Cedar Works, a Virginia corporation with main offices in Norfolk, Va., it was announced recently by officials of the paper company.

A spokesman said that the paper company had exercised an option to purchase approximately 136,000 acres of land in Dare, Hyde, Tyrrell, and Washington Counties.

Actual transfer of the title will take place at a closing to be held on or before August 25.

When the transaction is completed the paper company will take title to all lands of the Virginia corporation in the four counties, but not such physical properties as plants, factories, mills, buildings, logging equipment, and other such facilities owned by Richmond Cedar Works.

Purchase price of the land has been set at a consideration which will average about $5.50 per acre.

The bulk of the acreage is located in Tyrrell County. Among the larger single tracts are about 115,000 in Tyrrell and Hyde Counties, commonly known as the Josiah Collins Patent; about 13,350 acres in Dare County, located on the Alligator River and known locally as the McRae and Rodman lands, and around 5875 acres in Washington County, in an area generally known as Bull's Bay Swamp.

The company spokesman said, that while badly cut over in the past, the land is considered by its foresters to have a good forest potential which, under a sound, long-term management program, backed by forest and soil research, may provide the company with good pulpwood reserves for the future. Residual stands of pine cover about half the area and the balance is in cedar and mixtures of pine and such hardwoods as gum, oak, and poplar.

A wide expanse of the area offers opportunities for natural reseeding into pine, while other areas will require planting and considerable research work to improve growing conditions before harvestable timber will result, the company spokesman said.

The property will be operated and managed as part of the company's North Carolina woodlands project, which is directed by William Ernst, Jr., whose staff maintains headquarters at Manteo, N. C. The paper company acquired considerable timberland in Dare County last year when it purchased about 150,000 acres from Dare Corp.

When it takes possession of the Richmond Cedar Works property the paper company will manage it on a continuing yield basis similar to that being instituted on the former Dare Corp. lands. The basic objective of such a program is to develop the productivity of the land to a point where it is capable of growing and yielding successive crops of good timber, year after year.

Prevention of fires on the land will be the first consideration in the development of the management program and a broad protection program will be worked out in cooperation with state foresters.

"We must prevent fires on this land if we are ever to attain our goal of a perpetual forest economy for this area of North Carolina," Mr. Ernst, the woodlands manager, explained. "With the cooperation of landowners throughout the area, we hope to be able to develop a program which will be beneficial to the entire community."

Rayonier

A fellowship has been established at the Georgia Institute of Technology by Rayonier, Inc., the chemical cellulose producer. The fellowship, which is in the amount of $2500, will be used to further the study of cellulose and the silvichemicals. Silvichemicals are those chemicals other than cellulose stemming from wood, Dr. Van Leer said.

A large number of Georgia Tech graduate students are expected to apply for the fellowship.

James T. Sheehy, Rayonier executive vice-president, representing the company at ceremonies held at Atlanta, said that although companies such as Rayonier conduct their own extensive research and studies in both cellulose and the silvichemicals, there is a strong feeling in the industry that additional outside study needs to be encouraged "as the field of silvichemicals, particularly, is quite new. It may properly be regarded as almost virgin territory."

Mr. Sheehy's views are that with intensified study under way here and elsewhere, an important new segment of wood chemistry will develop. Rayonier, he said, is frankly hoping that new ways will be found to make greater use of the waste material resulting from chemical cellulose production.

J. T. Sheehy, Rayonier, Inc., presenting check to B. R. Van Leer of Georgia Tech. Harmon Caldwell of the University System of Georgia looks on

Mr. Sheehy pointed out that due to universal acceptance of the man-made fibers based on cellulose, plus manufacturers' ability to improve them, an entirely new farming concept was developing in Georgia and the Southeast. "The fact that we produce extremely high-grade chemical cellulose from southern pine for a wide variety of industries has given new impetus to pine tree farming in the South." He saw in this an important factor for a better balanced farm economy in this area.

It was a "very real triumph" when scientists developed a process for the manufacture of chemical cellulose from southern pine, Mr. Sheehy remarked, noting that the Rayonier plant at Fernandia Beach, Fla., was built in 1939 to use this process.

This followed by only nine years the successful process developed in the Northwest by the company for the use of western hemlock in chemical cellulose production, he declared.

The South has been growing cellulose as a crop for many years. First, it was in the form of cotton. But now trees are being cultivated for this purpose since wood has become the leading source of cellulose.

Mr. Sheehy observed that today one acre of land will grow more cellulose each year when planted in trees than when planted in cotton.

Rayonier, Inc, has plants in the Southeast and the Northwest, and has a fifth plant under construction at Jesup Ga., scheduled for completion in 1954.

J. N. Stephenson

At a luncheon given J. N. Stephenson, editor-in-chief of *Pulp and Paper Magazine of Canada*, in Montreal, on May 15, a surprise presentation was made to him by a group of outstanding men in the industry. The occasion was the completion of 35 years as editor of the four-volume textbook "Pulp and Paper Manufacture" sponsored jointly by the industry in Canada and the United States.

The gift was presented by John S. Bates, first chairman of the Technical Section of the Canadian Pulp and Paper Association. He said: "On behalf of those who have known and loved Steve for a third of a century, I am honored to hand this silver tray with the inscription: 'Presented to J. Newell Stephenson by some of his friends in the Canadian pulp and paper industry as an expression of their esteem, and to mark the 35th year of his service as editor of the Joint Textbook Committee of the paper industry, Montreal, 18th May, 1953.'"

The introductory address was made by Arthur L. Dawe, vice-president, Consolidated Paper Sales Ltd., who was secretary of the Canadian Pulp and Paper Association in 1916

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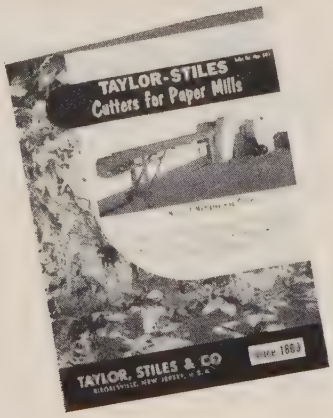

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when Mr. Stephenson came to Canada from the United States, where he graduated with honors from M.I.T. Other speakers were J. J. Harpell, former publisher of *Pulp and Paper Magazine;* R. W. Hovey, vice-president, Oxford Paper Sales Co., New York; George Hobart, president, Consolidated Paper Corp.

NYSCF

"Evaluation of Gas Transmission Rates of Flexible Packaging Materials" will be studied under a research contract granted to the Research Foundation of the State University of New York by the Office of the Quartermaster General, U. S. Army. Dr. Michael Szwarc and Dr. Vivian T. Stannett will conduct the study at the State University College of Forestry at Syracuse, according to an announcement by Dr. Edwin C. Jahn, associate dean of physical sciences and research at the college.

The contract calls for a basic analysis of the movement of different types of gases, under various conditions, into and through many types of polymeric and cellulosic film. The studies will be made by a postdoctorate fellow and two graduate students, working under the direction of Drs. Szwarc and Stannett.

Graduate followships for work on the project have been granted to Nicholas H. Alex and Richard Waack, both of Syracuse, who received B.S. degrees from the College of Forestry at commencement exercises June 1. Dr. Harry Frisch of the department of Physics, Syracuse University, will be engaged in the study during the Summer.

Dr. Szwarc, professor of physical and polymer chemistry, is internationally known for his research on bond dissociation energies and physical chemistry of polymers. He was awarded an honorary Doctor of Science degree in 1949 by the University of Manchester for his work on high-temperature homogeneous reaction kinetics.

Dr. Stannett, assistant professor of polymer chemistry, has had several years of industrial research experience in the cellulose acetate field. He is secretary of the Plastics Committee of the Technical Association of the Pulp and Paper Industry and is author of a recent book, "Cellulose Acetate Plastics."

I. P.-Southern Kraft

At a meeting of the Board of Directors of International Paper Co., Arthur L. Ross, assistant general Manager, Southern Kraft Div., was elected a vice-president of the company, it was announced recently by John H. Hinman, President.

A veteran of 28 years with the company, Mr. Ross was appointed assistant general manager of the Southern Kraft Div. last August after having served since 1939 as production manager of the company's nine integrated pulp and paper mills in the South.

A. L. Ross, Southern Kraft Div., International Paper Co.

Mr. Ross entered the paper industry in 1925 when he became associated with the late R. J. Cullen as chief chemist at the Bastrop, La., mill. When the Bastrop mill was purchased by International Paper, Mr. Ross joined the company. He served as pulp mill superintendent of the Bastrop and Louisiana mills and later as general superintendent of both mills. In 1938, he was assigned as general superintendent of the Georgetown mill before moving to division headquarters in Mobile in 1939 as production manager.

Mr. Ross will continue as assistant general manager of the Southern Kraft Div., which employs more than 14,000 men and women and last year produced more than 2,400,000 tons of kraft paper, board, and dissolving pulp in its nine modern mills.

WEYERHAEUSER

Weyerhaeuser Timber Foundation has established a fellowship in wood chemistry at Northwestern University (Evanston, Ill.), it was announced recently by J. P. Weyerhaeuser, Jr., WTF chairman.

The fellowship provides $2000 a year for three years and will be administered by Northwestern's chemistry department. The university will select the graduate student to whom the fellowship grant will be made. Dr. Charles D. Hurd was named by the university to be director of the fellowship.

Northwestern is the sixth educational institution to be granted WTF fellowships. Fellowships in forestry, pulp and papermaking and management development previously have been established at the University of Washington, Oregon State College, Institute of Paper Chemistry (Wis.), Yale University, and University of Chicago.

John G. Robinson, project engineer for Weyerhaeuser Timber Co.'s hardboard plant at Klamath Falls, Ore., will become superintendent of the new unit when it begins initial production this Fall, it was announced recently by Branch Manager R. R. Macartney.

During the last two years Robinson has worked closely with the firm's development department and Klamath Falls branch personnel in the planning and construction of Weyerhaeuser's first whole-wood fiberboard plant. Raw material for the new products will be mainly white fir, which previously was little used in lumber manufacture.

Macartney said the new unit will manufacture a wide variety of pressed and moldable fiber products. The production target is 90 million sq. ft. a year on a $^1/_8$-in. thickness basis.

Robinson joined Weyerhaeuser's Tacoma, Wash., engineering staff in 1946, after three years as an engineering officer with the Marine Corps in the Central Pacific area. He is currently a major in the Marine Reserve and the commanding officer of Tacoma's 23rd Special Infantry Co.

After attending the Missouri School of Mines and the University of Minnesota, Robinson in 1937 was employed by the Rhinelander Paper Co., in Wisconsin, as a construction engineer. He was called to active duty with the Marine Corps in 1942. Robinson is married and has four children.

Weyerhaeuser Timber Co. has named three new members to the firm's board of directors, Henry T. McKnight of Washington, D. C., Carleton Blunt of Chicago, and C. Davis Weyerhaeuser of Tacoma.

Howard W. Morgan, Tacoma, manager of the company's division since 1946, was named a vice-president by the board. Mr. McKnight, president of Cornwell, Inc., Washington agricultural advertising and public relations agency, is a grandson of one of the timber company founders. Mr. Blunt is a partner of the Chicago law firm, Bell, Boyd, Marshall & Lloyd, and a Vice-president of Laird Norton Co. He has taken an active interest in Weyerhaeuser Timber Co. affairs for many years. C. Davis Weyerhaeuser has been with the company since 1933, and currently manages its forestry, lands and timber activities.

The new directors fill vacancies created by the resignation of George R. Little, Winona, Minn., who had been a Weyerhaeuser director for 15 years, the resignation of E. W. Davis, St. Paul, a director since 1947, and the death of William L. McCormick, director and vice-president, who died in Tacoma, March 26.

Directors renamed to the board were Laird Bell, chairman, Chicago; Norton Clapp, Seattle; Edmond M. Cook, Davenport, Iowa; O. D. Fisher, Seattle; Edmund Hayes,

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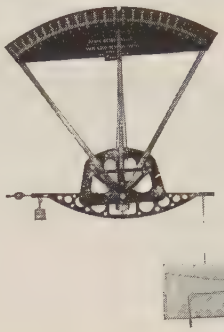

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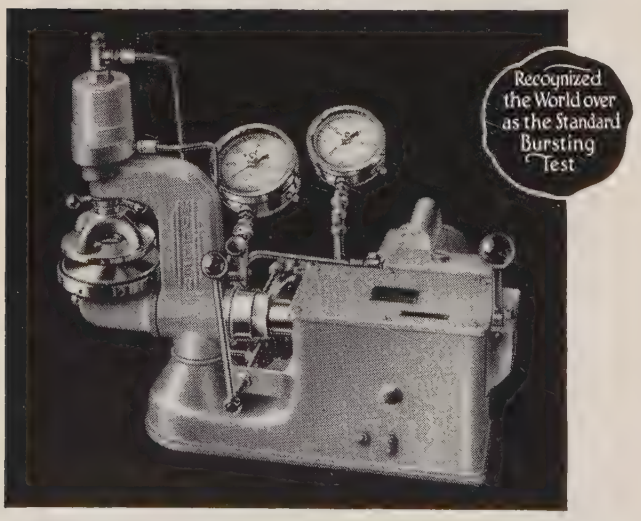

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Reappointed by the directors were the following Weyerhaeuser Timber Co. officers (all from Tacoma, unless otherwise noted): Laird Bell, chairman, Chicago; J. P. Weyerhaeuser, Jr., president; Chas. H. Ingram, vice-president and general manager; Edmund Hayes, Portland and F. K. Weyerhaeuser, St. Paul, vice-presidents; W. P. Gullander, financial vice-president; J. E. Nolan, vice-president and general counsel; George S. Long, Jr., secretary; Harold E. Nelson, treasurer; Robert W. Boyd, controller; Roy Voshmik, assistant secretary; and W. C. Robinson, W. A. Schink, and D. H. Swenson, assistant controllers. John M. Musser, St. Paul, was appointed an assistant secretary.

Howard W. Morgan, manager of Weyerhaeuser Timber Co.'s pulp division since 1946, recently was named a vice-president by the firm's board of directors.

The new vice-president has spent 25 years in the pulp and paper industry. Since joining Weyerhaeuser, he has directed the company's pulp manufacturing and distribution activities for its Everett and Longview, Wash., and Springfield, Ore., sulphite and sulphate pulp, containerboard and foodboard plants.

H. W. Morgan, Weyerhaeuser Timber Co.

Mr. Morgan, 51, was born in New Milford, Pa., and attended the Binghamton, N. Y., high school. He received his bachelor degree in science from New York State College of Forestry, Syracuse, in 1926 and his master's degree there in 1928.

He was a research engineer for Oxford Paper Co., Rumford, Me., from 1928 to 1932. During the next two years he returned to Syracuse as an assistant professor in the forestry college.

Mr. Morgan was appointed a department head at The Institute of Paper Chemistry, Appleton, Wis., in 1934. In 1938 he joined Munising Paper Co., Munising, Mich., where he held the posts of technical director, 1938–39, mill manager, 1940–42, and vice-president, 1943–46. During World War II Mr. Morgan served as an Army production consultant in Europe.

Since 1946 Mr. Morgan has been with Weyerhaeuser Timber Co. in Tacoma. He is married, and the couple have one son and two daughters.

P. H. GLATFELTER CO.

At a special meeting of the stockholders held in Spring Grove the company was given approval to proceed with an improvement program which will cost approximately $3,800,000.

The company has arranged through the First Boston Corp. for a $6,300,000 first mortgage loan with the Mutual Life Insurance Co. of New York. The cost of the plant improvements, as well as funds for providing additional working capital and paying off the old mortgage are to be provided for from the proceeds of the new mortgage.

P. H. Glatfelter, president of the P. H. Glatfelter Co., stated that the proposed expansion and modernization program is typical of the steps that must be taken by a progressive company in order to maintain leadership in its field. He said, "The Glatfelter company has grown to its present commanding position by following a clearly defined pattern which has resulted in an efficient, low cost, high quality, flexible, operating mill."

One of the first steps in the current program calls for converting the pulp mill from the soda process to the sulphate process. This change includes the addition of another digester, a new digester heat recovery system, a new liquor making and causticizing system, and the installation of a Combustion Engineering spray-type recovery boiler.

The company's existing bleach plant will be augmented with a chlorine dioxide stage and a completely modern bleached stock storage system.

The Glatfelter planning has taken into consideration air and stream pollution. For example, the new spray-type recovery boiler will be equipped with a Koppers electrostatic precipitator. The precipitator will remove 97½% of the solids from the exit gases of the new boiler. The chlorine dioxide bleaching stage will enable the company to improve the color of the water leaving the bleaching department—which has long been a serious problem with the company.

Trees for the Miami Valley

From now on there are going to be a lot more hardwood trees planted on farms in Miami County, Ohio. A tree planting machine recently was supplied by Hartzell Industries, Piqua, Ohio, for use by landowners in the area. This is believed to be the first instance of a forest industry providing a tree planter for woodland owners in a strictly hardwood region.

Miami County's new tree planter is no ordinary machine. It is a special model with a self-activating horn that "beeps" a signal to the operator to plant a tree at exact intervals of 7 ft. This provides for correct spacing of trees in the hardwood plantations.

The machine was thoroughly tested during a 10-acre planting demonstration sponsored by Hartzell Industries recently. The machine's inventor is Clayton J. Bruckner, president of the Waco Aircraft Co., of Troy, Ohio. Mr. Bruckner became interested in the problem of even spacing of machine-planted trees while working around his own farm.

He fastened a spacing device to the differential of his tractor. This activates a horn each time the machine moves 7 ft. The device can be adjusted to signal at any desired distance.

Mr. Bruckner says his invention, an inexpensive device, is his contribution to the cause of wise woodland management and tree farming. He has agreed to supply blueprints of the spacer attachment on request.

The Miami County tree planting machine supplied by Hartzell Industries is being used under supervision of Joe Fresoln, district farm forester. Recently the company sent trucks to the state nursery and brought back the county's full quota of tree planting stock for distribution to local landowners. Hartzell Industries, a member of the American Walnut Manufacturers Assn., was the first company in that organization to place its woodlands under the industry-sponsored Tree Farm program in Ohio.

Time-Life

The sister craft of the world's largest seagoing barge, the *N. L. Wallace*, was recently launched for Time, Inc., at the Dravo Corp. shipyard in Wilmington, Del.

The new barge, christened the *C. L. Stillman* in honor of the executive vice-president of Time, Inc., was built to augment the publishing corporation's waterways transportation of rolls of paper stock from Maine to Chicago.

A 211-ft. vessel, the barge is similar to the *N. L. Wallace*, built for Time, Inc., by Dravo in 1950. It is capable of carrying enough paper in one trip (2000 tons) to print some 4,000,000 copies of *Life* magazine.

The first barge Dravo built for Time, Inc., the *N. L. Wallace*, has been in service between the St. Regis Paper Co. mill at Bucksport, Me., and Time warehouses in Philadelphia and Chicago. Successful performance of the *Wallace* led to the decision of Time, Inc., officials to order the second barge.

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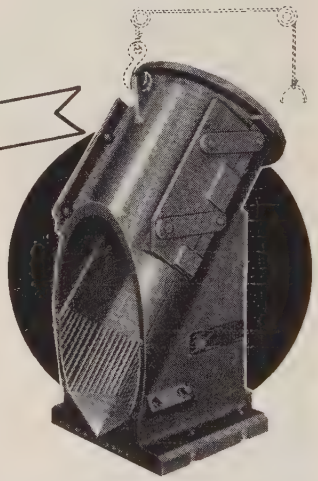

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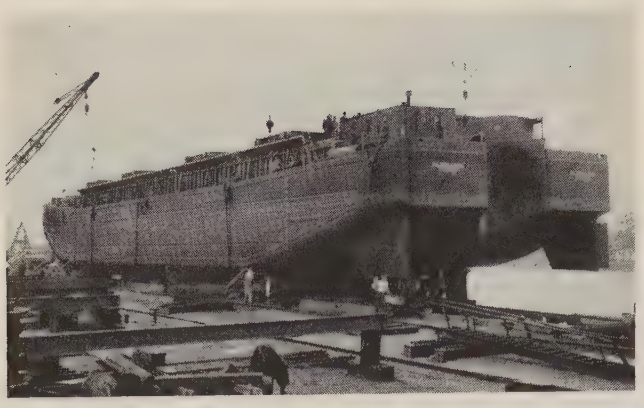


The* C. L. Stillman, *built for Time, Inc., being launched at the Wilmington, Del., shipyard of the Dravo Corp.

The *Wallace* was designed specifically to carry rolls of high-grade coated paper on which *Life* magazine and other Time, Inc., publications (*Time, Fortune, Architectural Forum,* and *House and Home*) are printed. The barge made seven round trips during 1952 between Bucksport and Chicago, via the Hudson River, New York State Barge Canal, and the Great Lakes.

Walter J. Heavney, general traffic manager of Time, Inc., pointed out the vessel could have made eight trips but a lock failure in the barge canal forced a detour up the St. Lawrence River and down the Atlantic Coast to Bucksport.

During the Winter months, when the barge canal is closed by ice, the barge operates to Philadelphia where a part of each week's issue of *Life* is printed by the Cuneo Eastern Press. The round trip between Bucksport and Philadelphia requires about eight days.

On return trips from Chicago, the barge carries grain or other bulk cargo. In three hours the vessel can be loaded with 65,000 bushels of grain which will be discharged at Albany or New York City, or any other intermediate ports between New York and Bucksport.

Of welded steel construction throughout, the vessel carries the highest classification of the American Bureau of Shipping. It also is classified by the Coast Guard for coastal, river, and lake operations.

The paper rolls, which require careful handling to prevent damage, are protected against the weather by watertight rolling hatch covers on the barge. These covers, a Dravo development, also permit easy unloading. Special cranes are used at Time's warehouses to lift the $1^1/_2$-ton rolls from the barge.

Both barges are equipped with modern, insulated quarters for their crews.

Tugs of the Moran Towing & Transportation Co. tow the vessels on the 1700-mile trips to Chicago which require an average of 14 days. Each barge has a notched stern to hold the bow of a tug during narrow-channel pushing. In open water, along the coast and on the lakes, the barge is pulled behind the tug.

Lion Fodder

Did you ever try to raise a lion without fresh meat by feeding it something made out of spruce trees?

The Fort Worth zoo raised a big, strong, two-year-old lioness named Mygrasue to prove it can be done. Mygrasue has never tasted fresh meat, but she has eaten one-half her own weight in a by-product of a Wisconsin mill, the Wisconsin Pulp and Paper Information Service announces. That is important news to zoo nutritionists who are worried about the rapid decrease in supplies of horse meat that has always been the principal diet for caged carnivorous animals. Statisticians calculate that by 1960 the supply of horse meat will practically disappear, and you can't feed lions and tigers on worn-out tractors.

Torula yeast made by Rhinelander Paper Co. supplied essential vitamins and protein in the Texas lion's meatless ration. She grew faster than other lion cubs according to zoo records, weighing 25 lb. by the time she was four months old.

Mygrasue had a hardhearted mother who would not take care of her. So the zoo-keeper's wife reared the "kitten" as a bottle baby, and gradually shifted the feedings over to a food powder provided by a South Bend, Ind., maker of pet foods in consultation with T. D. Luckey, biochemist, who is a student of zoo nutrition. The product looks like a mixture of chicken feed and red sawdust when dry, but acquires a texture like hamburger when water is added.

An article in *Parks & Recreation,* trade publication that covers care of zoo animals, says that zoo-keepers everywhere have an eye on the lion house at Fort Worth. Some of the older cats may never change their eating habits, the writer declares, but Mygrasue and her meatless meals have opened the way for feeding prepared foods to carnivorous animals.

Crown Zellerbach

Four Colgate University economists will make an on-the-spot four-week study of the operations of the Crown Zellerbach Corp. on the Pacific Coast, from June 22 to July 17.

Places to be visited are Crown Zellerbach headquarters at San Francisco, Pacific Northwest headquarters at Portland, tree farms in Oregon and Washington, and company production units at Camas, Wash., West Linn, Ore., and San Leandro, Calif.

The four men will study all phases of the company, including administration, production, forest management, labor relationships, and marketing problems. Colgate officials selected Crown Zellerbach for the teacher study because it is one of the largest and most versatile pulp and paper concerns in the country.

From Colgate's point of view, the project will give members of its faculty an opportunity to apply theoretical economics to a specific firm and its problems and also learn how these theories might work out in practice. From their intimate contact with Crown Zellerbach operations the Colgate teachers plan to develop test material and specific case studies to make their teaching of economics more effective.

The objectives of the trip are similar to those of the Textile Study Project recently completed by several members of the faculty.

Participating in the West Coast enterprise next month will

Wilson Farman, Lester Blum, W. C. Kessler, and F. A. Farnsworth of Colgate University

be Professor William C. Kessler, Associate Professor Lester Blum, Associate Professor Frank A. Farnsworth, and Assistant Professor Wilson Farman. All are members of the Economics department.

South America

Latin-America's vast forests may someday help solve the world's newsprint shortage.

But before that goal can be achieved, the continent's pulp and paper industry will have to undergo a $700,000,000 expansion program.

That's the gist of a report made public by the Economic Commission for Latin America which has completed an extensive survey of the region's pulp and paper resources.

"Latin America in general, and most of the individual countries have sufficient fibrous resources not only to meet their domestic requirements but also to contribute, through reports, to the reduction of the world shortage of paper and raw materials for paper," the commission found.

The pine forests of Latin America alone are capable of meeting the entire needs of the region although they cover only 5% of its total forest area, the survey says.

Besides the pine woods there are tropical and semitropical forests of hardwoods, huge supplies of wheat straw and sugar cane bagasse—a waste product of the sugar cane mills. All of these can be used in making paper.

The Latin-American commission agrees with other analysts who have warned that the world shortage of newsprint, paperboard, and other pulp and paper products is becoming more serious. It cites figures compiled by the United Nations Food and Agriculture Organization pointing to a probable world demand of 49,000,000 tons of pulp by 1960—excluding the Latin-American nations. That would be an increase of 19,000,000 tons over current pulp consumption.

Joint production of Canada, the United States, and Europe will fall short of the 1960 demand, the commission believes. But, it says, Latin America could develop a surplus supply that would make up the difference.

At present the Latin-American paper industry comprises 190 mills, most of them located in Argentina, Brazil, Chile, and Mexico. They produce 989,000 tons of paper and paperboard a year, including 48,000 tons of newsprint. This supplies only a small part of the area's present needs.

The commission report envisions an expansion program that would include the building of more than 50 "large" pulp and paper mills during the next 12 years. Output of fibrous material would be increased to 8,500,000 tons annually. This would meet Latin-America's anticipated requirements and leave a surplus of 1,500,000 tons available for export.

This construction program would cost an estimated $700,000,000. But that's not all. Many other new facilities would be needed.

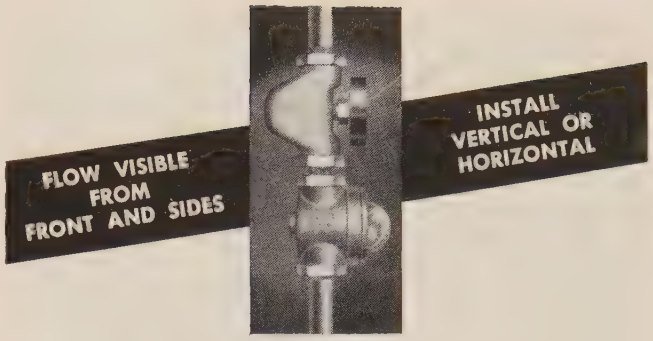
Latin-American electric power capacity would have to be increased by about 3,500,000 kw. Additional fuel supplies equivalent to 160,000 tons of coal a year would have to be provided. The expanded pulp and paper industry would also consume 140,000 additional tons of sodium chloride annually and 110,000 tons of lime.

It would also be necessary, the survey points out, to insure an abundant water supply for the industry and to build many miles of new highway and rail facilities, not only to obtain access to the forests but also to transport finished products.

A program of such magnitude the commission says, had best be undertaken jointly by entire groups of nations rather than by individual countries going it alone.

Kenora

More efficient operation of the Jonsson knotters in the refining of sulphite pulp stock at the Kenora mill will result from a new type of consistency regulator recently installed. Called the Askania regulator, it automatically regulates the consistency



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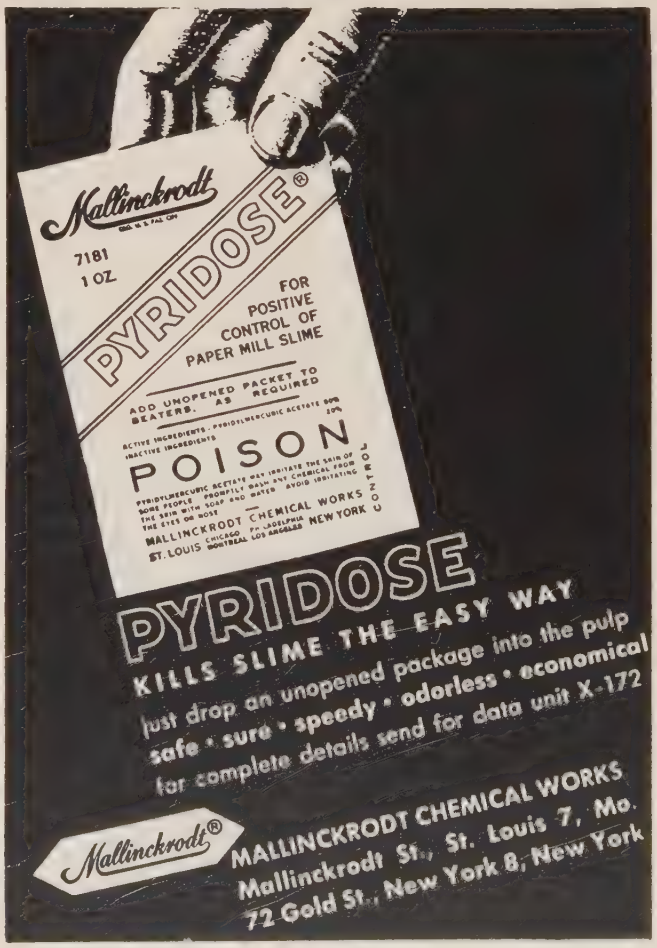
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of the stock being pumped from the brown tank in the sulphite mill to the knotters in the screen room.

Pulp consistency is the percentage of pulp present in any mixture of pulp and water. Certain standards must be met for maximum efficiency of the various screening and refining processes. The stock going to the Jonsson knotters must be at a very low consistency, and most consistency regulators are not constructed to accurately control such thin mixtures. The Askania regulator is very useful for consistency regulation in these cases.

As with all regulation, the problem of consistency regulation is in two parts. First, detection and measurement of variations and, second, operation of a valve in the dilution water line to correct variations.

The setup for measuring consistency changes consists of three boxes in series at varying heights. A sample of stock from the main flow passes through the upper headbox, where knots and slivers are screened out. This empties into the center box, which is a constant flow headbox, and this delivers the sample at a constant flow to the lower, or detector box.

In this box is a rotating perforated cylinder. The sample flows over the cylinder. Fiber from the sample is deposited as a pad on the cylinder, while white water drains through. The pad of pulp cuts down on this drainage, and results in a build-up in the stock level on the upstream side.

Drainage rate of white water through the rotating cylinder determines the thickness of the pad on the cylinder. Stock level on the upstream side varies, in turn, with the thickness of the pad. The drainage rate is a combination of two properties—stock freeness and consistency. Since the freeness of unrefined spruce sulphite is, for all practical purposes, constant, then the drainage rate and the stock level are dependent on stock consistency alone.

The Askania regulator works on this principle. Variations in the stock level are measured by a bubble tube system. Changes create variations in air pressure in the system, which are transmitted to the regulator and through it by means of oil pressure to a power cylinder. This cylinder operates a butterfly valve in the water dilution line. When a change in consistency is noted by the detector box, the Askania regulator and the butterfly valve vary the amount of dilution water being added to the stock in a mixing box ahead of the stock pump, to correct it.

A stainless steel spiral heat exchanger, for cooling relief gases from the digesters, is expected to result in savings of a substantial nature at Kenora. Installation was completed in March.

The acid gases formed during the preparation of sulphite pulp are relieved into wooden acid storage tanks to reclaim the acid for re-use. Since the gases are very hot, there is a limit to the speed at which they can be relieved, otherwise rapid deterioration of the tanks results. Previously the digesters were blown at a fairly high pressure to slow down relief of the gases. This allowed considerable amounts of the gases to escape up the vomit stack at each blow.

With the heat exchanger installation, the pressure in the digesters can be sharply reduced. The low-pressure relief gases pass through the cooler and are cooled to such a degree that they have no effect on the wooden acid storage tank. This reduces the amount of hot gases lost to the atmosphere, and therefore an increase in the acid reclaimed. A direct result is the saving of approximately 8 lb. of sulphur—used to manufacture the gas—per ton of pulp produced, or something over 100 tons a year.

An additional saving is made in steam power used in the acid-making process. Water heated in cooling the gases will be used in the acid-making process instead of steam-heated water. It is estimated that this would amount to a saving of 15,000 lb. of steam per day, or a yearly saving of over $2000.

The cooler is of sufficient capacity to handle relief from all the digesters, thus making possible cold acid cooking. This would allow major repairs to the accumulators to be done during the week, and not require loss of time, or lapping of sulphite to carry the machines, while this work is undertaken.

Otto Behrend

Tuesday, May 12, was a significant day in the life of Otto Frederick Behrend. It was an equally significant day for Hammermill, for on that date the company's beloved co-founder and treasurer retired.

Hammermill's oldest-in-service employee, Dr. Behrend has been treasurer of the company throughout its 55-year history. In perfect health prior to being seriously injured by an Erie motorist a year ago, the Doctor has never fully recovered—and announced last November his decision to retire for reasons of health as of this month's Annual Meeting of Stockholders.

Like most companies, Hammermill reflects the ideals and character of the men who played a dominant role in its development. The success of Hammermill is due—in no small degree—to the fact that it reflects the ideals and character of Otto F. Behrend.

Born in Coeslin, a small town in East Germany, on Oct. 17, 1872, Otto Behrend as a lad moved with his parents to a wooded area of Germany known as Hammermuelle where his father built a paper mill. Living in the woods near the paper mill, Otto and his six brothers and sisters received most of their early schooling from a private tutor, for the nearest school was almost 30 miles away.

In 1890 he entered the University of Berlin, and received his Ph.D. degree in chemistry there in 1896. For two years following his graduation, he worked in various paper mills in Germany, gaining practical experience in the art of papermaking.

And, then, in 1898 his father, Moritz, broached the subject of building a new paper mill in America. In America, he declared there was great opportunity, while in Germany there was nothing but one war after another. Dr. Behrend liked the idea—for he had heard a great deal about America from his brother Ernst who had come to the United States two years before.

And so it was that Dr. Behrend came to America, and in June, 1898, the two brothers, along with their father, founded the Hammermill Paper Co. It was not easy, building and operating a new paper mill with green hands—and Dr. Behrend soon found himself doing a half dozen or more separate jobs. In the early days he was not only Hammermill's treasurer—he was the company vice-president, secretary and entire laboratory staff as well. In connection with his laboratory work, it might well be mentioned that Dr. Behrend was an industry pioneer in establishing laboratory control and chemical testing in the manufacture of pulp and paper.

Fort Frances

Number 5 paper machine, which has been operating almost continuously for the past 39 years at Fort Frances, now has a new lease on life.

On the morning of February 1 the machine was shut down, and a crew of Mandonians began the job of dismantling and rebuilding the machine. The task was completed four weeks later, and the maintenance department turned the machine over to the paper machine crew at 2:20 p.m. on March 2. Forty minutes later they had paper on the reel and ran for 17 hours without a break.

The work done on Nov. 5 closely paralleled that done on No. 6 in July 1949. All sections of the machine came in for attention, beginning with the driving unit. Since its installation in 1914, the machine had been driven by an American Ball reciprocating steam engine. This supplied power through a belt drive to a shaft running the length of the machine. Power for the various sections was taken off the shaft by means of cone pulleys. These, in turn, transmitted

power through belts and wooden core gears to operate the wire, presses, driers, calender stack, and reel. The age and condition of the steam engine limited the speed range of the machine to 600 to 840 f.p.m. This, combined with the fact that the wooden core gears caused considerable undesirable vibration, made the machine unsuitable for the manufacture of better grades of paper.

This old-fashioned system was replaced with a sectional electric drive. This consists of a series of motors installed along the back side of the machine to individually drive the various units. Over-all control of power to the machine is regulated from a master panel. Individual units can be controlled at the machine by the operators. Each section can be operated independently of the others, as well as in synchronization with them.

With this new power and control system, the machine has a speed range of from 200 to 1200 f.p.m. making it capable of producing a wide range of paper products. Considerable savings in maintenance and greatly improved housekeeping will result from this change-over. It will also have the direct result of increasing production by 1500 tons per day.

At the wet end of the machine the Bird screens and headbox were reconditioned and raised to improve the flow of stock. A new fourdrinier section was also installed. This is a full removable unit, which makes changing of wires easier and shortens the down time of the machine for this operation.

The press section, between the wire and driers, was entirely replaced. The new installations consisted of a suction first press, a two-roll straight-through suction second press, and a smoothing press.

In the drier section one drier roll was replaced and six additional ones were installed. This will provide more efficient drying of the sheet both for normal speeds and the anticipated higher speeds which will be possible. It is interesting to note that no lengthening of the machine was necessary to accommodate the extra driers, due to the compact design of the new press sections.

No change was made in the calender stack except for some necessary machining, but the Pope-type reel was replaced with a new unit of the same type.

As with No. 6 machine, the old winder on No. 5 was replaced with a Cameron winder. This gives faster and more efficient winding and trimming of the machine-width jumbo roll from the reel into sizes required by the customer. The new winder is capable of speeds up to 3000 f.p.m. to keep up to machine production. This winder is fitted with a regenerative drive.

The regenerative drive system has many advantages over the ordinary type. It conserves electric power in the winding process, and makes winder operation automatic and more efficient. The system has a generator attached to the unwinding shaft. This, and the winding motor, are wired together electrically. Once the winder is started, the generator produces electrical energy to operate the winder motor and only the power loss has to be made up from the regular power source. The generator also exerts an efficient braking force on the unwinding roll, and is so hooked up that it automatically regulates the tension on the sheet as the winding progresses thereby insuring perfectly wound rolls from the winder. Braking and sheet tension can also be regulated independently by the operator.

As well as these major improvements, a host of supplemental changes were made such as a piping, electrical wiring, improving of gears and bearings, etc. The machine has individual stock cleaners for both groundwood and sulphite pulps.

All of the work on the machine was performed by Fort Frances mill employees. They are to be congratulated on the speed and efficiency with which they perform their work.

The rehabilitation of No. 5 paper machine is a part of Mando's continuing program of modernization and expansion of plants and equipment in which the company has expended $33,000,000 during the past eight years. Through it the life of the machine has been extended indefinitely and will be able to play its part in increasing and improving our production immediately. It will also aid production of more and better grades of paper when it becomes practical.

Kimberly-Clark

A variety of studies on disease and insect damage to forest trees are now under way at the recently opened Kimberly Clark laboratory in Iron Mountain, Mich. Applied research carried on there will benefit the entire Wisconsin, Michigan, Minnesota area where forest industry leaders are cooperating to make the Lake States self-sufficient in pulpwood supply.

The new laboratory is manned by a forest pathologist and a forest entomologist. Personnel of the Bonifas Lumber Co., a Kimberly-Clark subsidiary, work in the laboratory. Results of applied research at the laboratory will be made available to other woodland owners.

Currently the laboratory technicians are conducting research on white grubs that chew off roots of spruce seedlings, causing serious damage to tree plantations. Experiments are under way to find out what type of insecticide can be put on the roots before seedlings are planted so young trees can be protected during the first two years of their life in the plantation soil.

Another laboratory project involves study of balsam fir decay which destroys the inside of a tree making it unfit for pulpwood use. Studies also are being made of the hypoxylon canker that attacks poplar trees.

This year 6500 cords of pulpwood at Boon, Ont., and 1000 cords at Niagara, Wis., are being sprayed to find out how to control losses due to wood borers.

Mission of the new Kimberly-Clark laboratory is to make it possible for Lake States forests to grow continuing wood crops of larger volume and higher quality.

Great Northern

The June 5 issue of the Bangor *Daily News* was the first full press run on newsprint, using a large percentage of hardwood groundwood pulp, in the United States and undoubtedly in the entire world.

The sheet from which the test run was made contains in excess of 30% hardwood pulp.

Ordinary newsprint is composed of softwood groundwood pulp and sulphite.

The special newsprint was manufactured by the Great Northern Paper Co.; as is part of the Bangor *Daily News*' regular newsprint supply.

Approximately 15 tons of hardwood newsprint were used in the June 5 editions of the paper.

Manuel C. McDonald, president of the Great Northern Paper Co., said:

"This is the first extensive commercial use of Great Northern newsprint containing a percentage of mechanical hardwood pulp high enough to justify the expansion program which the company is now undertaking."

He said that the hardwood newsprint for the June 5 editions was manufactured in "the orthodox manner."

No changes were necessitated on the papermaking machines, he said. Nor were any unusual precautions and extra attentions taken regarding mechanical operation.

Richard K. Warren, assistant publisher of the Bangor *Daily News*, said that the May 15 editions of the paper were published with three rolls of hardwood newsprint mixed in with ordinary newsprint.

There was no public announcement at that time about the coordinating experiment of the Bangor *Daily News* and the Great Northern Paper Co.

Commenting on the May 15 test run, Mr. Warren said:

"The results were excellent.

"The newsprint ran well over the presses. There was no pressroom difficulty.

"Press speed was 35,000 per hour, the same as a normal run.

"There seemed to be no difference between the hardwood newsprint and the regular newsprint. Strength, opacity (want of transparency), and ink absorption were the same."

Company officials understand that the Great Northern is the only company now commercially producing the hardwood pulp.

Mr. McDonald, noting the significance of the June 5 press run, stated:

"The Great Northern has long recognized the economic potential of the hardwood stands on its own and other lands tributary to the mills, and has for several years conducted an extensive program of study and experimentation on the various commercial and experimental methods of pulping the hardwood species, in an effort to develop a low-cost hardwood pulp with characteristics suitable for use in substantial proportions in the manufacture of newsprint."

He noted that "the recurrent shortage in newsprint supply is a condition well known to observers of the paper industry."

The Great Northern president said that the company "recognizes the need for substantially increased production of newsprint, but always has in mind the supply of spruce and fir pulpwood available to its mills."

Referring to the company's $32,000,000 expansion program, he said that "all new production by the company can be achieved on the basis of not taking any more softwoods than we now are using."

Great Northern officials stressed that the new product is the result of industry financing or research.

Research on the basic idea of hardwood pulping began several years ago at the N. Y. State College of Forestry at Syracuse, N. Y. The research was financed by the Empire State Pulp Research Associates, of which the Great Northern is a member.

The company's Bureau of Tests has studied hardwood utilization for several years. During 1952, company tests concentrated on the manufacture of pretreated groundwood.

Since February, a 50-ton-a-day Great Northern mill at East Millinocket has been producing this hardwood pulp.

Design and field supervision of the plant were provided by the company's engineering department, and, according to company officials, it is intended that the general design on the East Millinocket plant expansion will be carried out by the company's own engineers.

The 50-ton plant includes the following equipment: two horizontal pretreating pressure vessels, one Great Northern grinder, and auxiliary equipment.

During the Summer of 1954, a new paper machine will be installed and production of hardwood pulp is expected to be boosted to about 175–180 tons a day.

In 1955, it is anticipated that another paper machine will be installed, and hardwood pulp production is expected to be further increased to about 250 tons a day.

National Container 25th Anniversary

National Container Corp. began with 15 years of experience. Its history differs from most success stories in that National started as an experienced company in what was probably the largest corrugated box plant of its day. The original factory covered three city blocks in Long Island City, N. Y., one of America's great industrial centers. National's experience came from the man of the four veteran manufacturing concerns—Columbia Corrugated Co., William Herman Co., New York Corrugated Case Co., and International Corrugated Paper Co.—which amalgamated to form National Container Corp. Idea and impetus for the merger came from Samuel Kipnis, the company's first and only president. Under the guidance of Saul Bernstein, an attorney, terms were agreed upon and contracts were prepared and signed.

This combining of resources gave the new company many obvious advantages: economy in overhead (rent, supervision, office costs, etc.); efficiency in production; strength in buying power; plus the better utilization and specialization of executive talents.

It was a Saturday afternoon early in 1928 when the founders of National Container met for the first time at their plant in Long Island City. They had agreed to pay the United States Government $1,000,000 for the property, which was originally built during World War I.

The following Monday, trucks from the consolidated companies rolled into the building to deliver the corrugators, printers, slotters, and other machinery and equipment needed to make corrugated paper shipping boxes. Harry Ginsberg, one of the original partners and now chairman of the Board, stood in the middle of the 500-ft.-long plant on a raised platform and directed the placing of the machinery, forming the first production line. By June the first boxes came off the assembly line.

At that time, as today, salesmanship in the corrugated paper shipping container industry was based largely on the idea of change—that is, persuading users of cumbersome wood crates and boxes to change over to less expensive and more practical corrugated paper boxes. One of National's first salesmen once visited the purchasing agent of a large brewery. Before a few minutes passed, the salesman was tossed bodily out of the office. "Who ever heard of shipping bottles of beer in paper boxes?" the irate agent called after him. Today that same purchasing agent sees literally billions of bottles and cans of beer move from brewery to retailer to consumer, neatly and economically packaged in corrugated paper containers.

The great forward strides of the corrugated paper shipping container industry came from offering shippers a maximum of strength and a minimum of weight, at lowest possible cost. With a vast store of experience gained in packaging the products of a nation over a quarter of a century, National's personnel were successful in inducing shippers to adopt corrugated paper containers for such diverse commodities as soft drinks and motor oil, glassware and roofing material, plastics and fruit juices, biscuits and furniture, liquor and lawn mowers, beer and cheese, light bulbs and engine parts, mattresses and television sets, bread and butter, books and bowling balls, chemicals and cream puffs, bacon and eggs, fruits and vegetables—food, building materials, and clothing. There exists no product today which cannot be securely packaged and shipped in a kraft corrugated paper box.

For its first year, National reported sales of $1,000,000. Long Island City that year produced 250,000,000 sq. ft. of boxes, a humble but healthy beginning compared with National Container Corp.'s 3,100,000,000 sq. ft. of container production and over $71,000,000 in aggregate sales for its several products during 1951.

In 1929 another local box company, Hygrade-Eagle, joined National. Later that year, National stock was made available to the public and subsequently traded on the old Curb Exchange. In 1937 the stock was listed on the New York Stock Exchange.

With more orders than its productive facilities could keep up with, the company felt secure enough to expand its operations. In 1930, the company opened its original Philadelphia plant. In Bradford, the heart of Pennsylvania's oil fields, National in 1935 acquired a third plant. With the addition of this plant, the company made one of its great gains in the person of Lester R. Edwards, president of that company and a vice-president and director of National Container.

By 1935, just 7 years after it was founded, National could boast of being one of the few companies in the corrugated paper shipping container industry which passed through each depression year with a profit.

During this initial period, the groundwork of the present-

day company was established. Systems and methods of giving better service to customers and prospects, of designing better containers and of controlling the quality of all manufacturing processes, were implanted firmly. Eight of National's twelve present directors, all senior operating executives of the company, are alumni of the Long Island City plant. By 1935, National Container was producing about 456,000,000 sq. ft. of corrugated and fiber boxes at its three plants—Long Island City, Bradford, and Philadelphia. Keeping these plants in full production made the company one of the largest users of kraft paperboard, which it bought from southern paper mills. The 30,000 tons of kraft paperboard used each year by its box converting plants represented National Container's largest single manufacturing cost.

As the tempo of industry increased throughout the country, paper mills often were unable to meet the full demands of their box manufacturer customers. The company frequently was obliged to turn to the open market for additional paperboard, often having to pay premium prices. What the company desired was a guaranteed and adequate supply of paperboard. With an assured and steady source of this raw material, the company could also open more box plants. Without it, National Container would remain static.

National's executives also knew that through integration of operations—"from the tree to the finished product"—they would obtain the profits at the mill level. By controlling the quality and source of paperboard, the company could offer its customers better grade shipping containers at competitive prices. Here National's progressive-aggressive president jumped the gun on competition and set into motion a long-range expansion program, the first step being the building of the company's own paperboard mill.

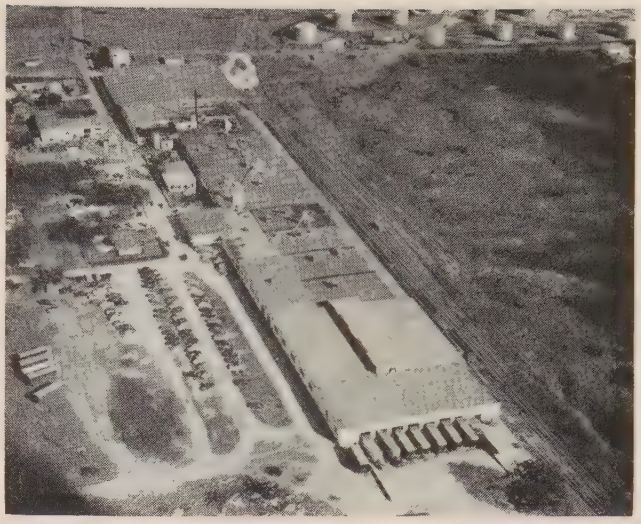
Jacksonville

After considering many locations throughout the southern states, the company bought a 15-acre site containing several buildings along the banks of the St. John's River, within the city limits of Jacksonville, Fla. Additional capital was raised in 1937 through underwriters, and subsequently, the common stock was listed on New York Stock Exchange.

Construction began late in 1937 on a kraft pulp, board, and paper mill designed to produce 200 tons per day. This involved both the remodeling of existing structures and installation of papermaking machinery. The site was relatively small but extremely well situated for receipt of raw materials and shipment of finished paperboard. Later, when demands for additional paperboard evidenced tremendous growth of the company, the mill, because of limited site area, was forced to expand vertically instead of laterally. As a result, the mill now towers in parts over seven stories high and is probably the largest producer of paperboard per acre of mill area in the country.

In the late months of 1938, the first puff of smoke poured skyward from National's first mill, and kraft paperboard began to roll off the 212-in. fourdrinier paper machine at the rate of 220 tons per day. From the first week, production surpassed all estimates and expections. Originally designed to produce 220 tons per day, the Jacksonville mill now turns out close to 450 tons per day. Executive Vice-President J. L. Kipnis has among his responsibilities allocating of this production to company converting plants along with the output of other mills.

Through the years under the over-all management of Dick Laftman, who supervised its construction, Vice-President Bill Webster (Laftman's successor) and Vice-President Al Edwards, there has been a continuing process of modernization and replacement at the Jacksonville mill. The original fourdrinier papermaking machine remains, but the engineer who designed it would never recognize it today. Production of paperboard at National's Jacksonville mill is an around-the-clock, three-shifts-a-day, seven-days-a-week operation. It is a process of transformation—changing the form



The Jacksonville, Fla., converting plant of the National Container Corp.

of the cellulose in wood to paper. At the mill wood is barked, chipped, cooked, refined, treated with chemicals, and finally transformed into a strong kraft paper.

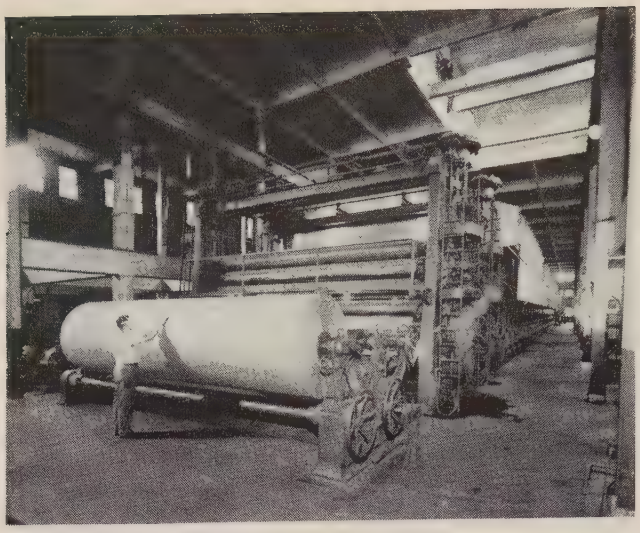
Through the ages papermaking has been closely allied with a people's cultural level. The Chinese made the first paper, as we know it, nearly 2000 years ago. About 900 A.D., the Egyptians learned to make paper; the secret spread across North Africa and was brought into Europe in 1150. The fourdrinier process used by most mills today was invented in England not quite 200 years ago. It is a process improved upon almost daily through research, experimentation, and quality control and is brought to its highest perfection at the Jacksonville mill. As the production of kraft paperboard from the Jacksonville mill increased, National sought new locations for additional converting plants. Within the mill building at Jacksonville, the company in 1938 installed a completely equipped boxmaking plant, creating in close proximity an entire production line—"from the tree to the finished product."

Within two years the Jacksonville box operation grew too large and was moved to a new location about one mile from the mill. There National built one of the largest and best-equipped converting plants in the country.

Today this plant is managed by Hayes H. McRae who also supervises the company's southern converting operations including plants in Miami; Rock Hill, S. C.; Atlanta; and Memphis. Embracing 240,000 sq. ft., the almost quarter-mile-long building is capable of handling 42 rail cars at one time. Its fleet of tractor and trailer combinations deliver millions of kraft containers every month to shippers and packers of agricultural products, furniture, canned goods, and other commodities vital to the American economy. Along with its closeness to the company's paperboard mill, the Jacksonville plant boasts an extremely efficient production line which can fabricate containers, at competitive prices, for users anywhere in the United States.

In 1948, National added another plant to its Florida roster. Within five years this plant, located in Miami, has become an important supplier of boxes not only in its territory but also for Central and South American trade. The plant, in addition, produces many special shipping containers for local growers of fruits and flowers. The city of Miami (population 249,276) has in recent years become an important industrial and air transportation center into which more than $1,000,000,000 for new construction has been invested since the termination of World War II.

Backed by an abundant supply of paperboard from the Jacksonville, Fla., mill, National Container's management



The 500 ft. long, 212-in. fourdrinier at the Jacksonville mill of the National Container Corp.

examined various markets during 1938 and 1939 as possible locations for new box plants. Reaching out more than 2000 miles across the country from its most westerly plant in Bradford, Pa., the company in 1940 leased a large building in the port area of Oakland, Calif., and installed a complete converting plant. Situated on the east side of San Francisco Bay, the box plant was adjacent to piers where great ships from all over the world docked to exchange cargoes.

National was sure that the West Coast with its temperate climate and huge fruit and canning industries would provide an excellent market for its products. The company also saw the beginnings of a vast industrial development in that part of the country, a prediction amply justified today by the hundreds of home appliances, auto parts, business machines, chemicals, and other industrial products for which the Oakland converting plant provides kraft shipping containers.

After Vice-President Al Edwards set the new Oakland plant into operation in 1940, George Schneider, who at 33 was a veteran box-man with 20 years in the business, was sent out to develop and expand this West Coast operation. For his work on the West Coast, Schneider was made a vice-president and director. Within a short time, the plant was serving customers as far south as Los Angeles, as far east as Salt Lake City, and north to the Canadian border.

With the end of World War II, about half of the orders for the Oakland plant came from the highly developed and rapidly expanding industrial area around Los Angeles, whose population from 1900 to 1950 increased about 1535%. In 1950, on $5^1/_2$ acres of land bought from the Atchison, Topeka and Santa Fe Railroad, National Container built a fully integrated converting plant in Los Angeles. This plant, supplying boxes to customers as far east as Utah, is now one of the largest in the area.

Big Island

National Container's second paper mill, at Big Island, nestles comfortably between two steep foothills of Virginia's famed Blue Ridge Mountains. Travelers along the tortuous highway 19 miles out of Lynchburg, admiring the scenic James River, might be surprised to see a busy paper mill set in such pastoral surroundings. Big Island natives say that the first paper mill ever built in Virginia once stood on the site of the present mill. Steeped in over a half century of quality papermaking, the Big Island mill was an important addition to National's first line of production. Acquired in 1944 when war demands for shipping containers reached a peak, Big Island produces stiff corrugating medium, the special 0.009 (called "nine-point") paperboard used for the fluted core of corrugated board. It is managed by A. T. Taylor who came to the mill in 1926. When taken over, the mill was producing 100 tons per day on its two fourdrinier papermaking machines. Immediately, a complete and continuous program got under way to increase production and to improve the pulp and paper facilities at the mill.

During 1944 a new continuous cooking pulp-making process pioneered a new method of manufacturing corrugating medium. Production of high-grade paper demanded constant quality control and testing; in 1946, National installed a modern laboratory.

Within a short time the modernization program was reflected in production, which jumped 50%. Today, Big Island produces 150 tons daily. In 1946 a new first-aid department with a registered nurse in attendance was inaugurated. This service is also used by Big Island's townspeople for treatment and emergencies. Accidents, which previously numbered dozens yearly, dropped considerably. During 1951, the mill suffered only two lost-time accidents and was awarded National's Inter-Plant Safety Award for the second time. Big Island is a family affair, having as many as ten employees with the same family name. Ninety-five of its 250 employees boast over 15 years of service. The value of paper produced at Big Island in 1951 was $6,000,000; payments to employees equaled almost $1,000,000. To produce Big Island's corrugating medium, the mill uses 25 different species of hardwoods. Its woodlands supply about 50% of pulpwood needs. The rest is bought from local farmers and landowners and delivered to the mill.

Ontonagon

Until the end of World War II, National Container had not found itself in a position to tap one of the most important commercial areas of the U. S.—the industrial midwest. The move to Los Angeles had made the company nationwide, but it was not yet in the truest sense "national." The acquisition of the Ontonagon paper mill in 1945, renamed the National Container Corp. of Michigan, represented two significant things to National. One was a foresighted recognition of an overwhelming postwar demand, soon to develop, for vast amounts of paperboard to be "chewed up" by National's converting plants. In an expanding economy, National could not afford to run short of board supply. The second significance of the Ontonagon purchase was that it was a move into America's industrial heartland and a strategic position within economical shipping distance of such centers as Chicago, Milwaukee, Minneapolis, and Detroit. Producing limited

National Container's Big Island, Va., mill

quantities of board when it was purchased, the Ontonagon mill—northernmost of National's installations—was soon modernized and given the best new equipment. It now produces kraft board for liner stock on a cylinder-type machine at the rate of 100 tons a day. National followed up its Ontonagon purchase with a series of leapfrogging movements designed to establish it firmly in the midwest area. A year later, in 1946, came the purchase of the Tomahawk paper mill in Wisconsin. Now well supplied with containerboard, National set about assuring itself of additional converting plants. In 1947, the Moore Box Co. in Chicago was acquired by National and subsequently expanded into one of the finest and most complete box shops in the United States. After purchasing the Chicago plant, the company not only rearranged and improved it but also enlarged it: from 38,000 sq. ft. of floor space in 1947 it grew to 74,000 in 1949, to 140,000 in 1951. It is now third largest in the National system. Under its manager, Leonard T. Moore, its production has grown to 35 million sq. ft. of corrugated products a month. Mr. Moore is also midwest division manager in charge of converting plants at Tomahawk, Wis.; Milwaukee; Chicago; Aurora, Ind.; East St. Louis, Ill.; and Dallas.

Late in 1947, the well-established converting plant in Aurora, Ind., was purchased from Martin Brothers. Aurora is situated at the juncture of Kentucky, Indiana, and Ohio—about 30 miles from Cincinnati—therefore centrally located to service another industrial area.

Tomahawk

In its Tomahawk mill and converting plant, situated on the Wisconsin River one mile south of Tomahawk, Wis., National owns what is now one of the most efficient and complete board manufacturing properties in the entire industry. When purchased by National Container in 1946, Tomahawk had two papermaking machines on which it produced bag paper in a variety of colors. National converted the entire operation to board making. Tomahawk also maintains its own plentiful power supply and since 1944 has owned and operated a 13-mile freight line (the Marinette, Tomahawk and Western Railroad) which connects it with both the Milwaukee Road and the Soo Line. In 1948 National made two additions to Tomahawk's landscape: a semichemical plant and a converting plant. The Tomahawk mill is managed by C. G. McLaren, who before National's purchase headed Tomahawk's logging operations. A vice-president of the company, McLaren is in charge of all National's northern mills and also serves on the committee supervising the Valdosta mill construction.

The Ontonagon paper mill which is located at Ontonagon, Mich.

Winter view of the National Container Tomahawk mill, Bradley, Wis.

Jaite

With its purchase of the Jaite Co. in June, 1951, National for the first time moved outside the paperboard box industry by extending and diversifying its line to include not only multiwall, heavy-duty paper bags but also special purpose display bags. The Jaite Co., founded in 1905 on the shores of the Cuyahoga River in Ohio south of Cleveland, is one of the nation's oldest makers of multiwall bags. Its first product was flour sacks, but in 1914 it began making puncture-proof and moistureproof bags. In 1925 it helped pioneer the development of the tough, pliable multiwall bags for shipping cement, lime, fertilizer, and other products. The introduction of "window" bags—an exclusive Jaite development—came in 1934. Ideal for displaying such items as potato chips, bread, and doughnuts, the glassine-fronted bags have become increasingly popular in U. S. self-service stores.

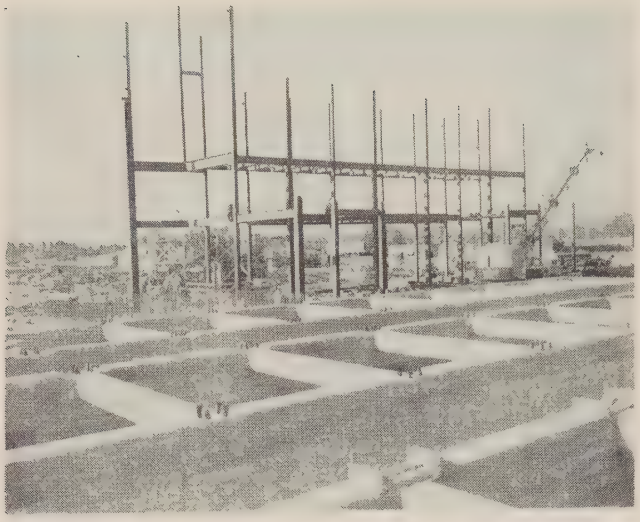
National put new life into the Jaite Co. and reinvigorated its sales program. Jaite's two 79-in. fourdrinier paper machines have been modernized. The bag plant can produce at the rate of 3000 tons of bags per month. Jaite's location between Akron and Cleveland not only assures it of a skilled labor supply but affords swift delivery of Jaite bags to manufacturers in major industrial areas. Always seeking ways to develop new kinds of bags, Jaite makes bags for packaging more than 500 different commodities ranging from mattresses to crushed glass.

Other Plants

Continuing its expansion plans, calculated to bring National Container's facilities and services to additional sales territories around the country, the company within the past 15 months has established four converting plants. The Dallas, Tex., plant is a completely new and fully integrated installation built in 1951 to National's specifications. A plant in Atlanta, Ga., was recently acquired through the purchase of an existing business. Its equipment and manufacturing facilties are now being modernized. National's Rock Hill, S. C., plant was opened in March, 1952, to serve all industry in North and South Carolina, Virginia, and West Virginia. The East St. Louis, Ill., plant established in October, 1952, gives National an entry into this industrial and agricultural territory. A new modern converting plant in Memphis, Tenn., is being equipped for production in the near future.

Valdosta

Valdosta is a fine little city in Georgia, best known to baseball fans as the home of a "farm team" for the Brooklyn



First steel beams erected Feb. 4, 1953, are riveted into place on the new Valdosta building

Dodgers. To auto travelers heading south from the Midwest to Miami Beach, Valdosta is a marker just 500 miles short of their destination. But to the naval stores trade (resins, turpentine), Valdosta is a capital city. Its location in the heart of a great pine belt ranks it high among the basis industries using this precious natural resource.

For many months it was a well-kept secret when National Container's Bill Webster surveyed the area. National had determined upon a great new paper mill. Its location was all-essential to its success and role in National's whole schedule of expansion. Every check, every study by the experienced eyes and minds of paper experts, company executives and outside consultants, confirmed Bill Webster's own decision. Valdosta was the ideal site (more specifically, the location is at Clyattville, some 9 miles from the town of Valdosta).

The surrounding country held millions of acres of fine standing pine. The terrain was equally ideal, with a gradual 150-ft. downward slope toward the Withlacoochee River, at a proper distance from the mill to allow for treatment of effluent mill wastage through a series of ponding areas to assure that no harmful waste would be carried down to the river. Valdosta citizens revealed sincere enthusiasm for the mill.

After obtaining a Certificate of Necessity and permission from its thousands of stockholders, the company raised sufficient funds for construction. One week after stockholders gave their approval, a contract for construction of a 500-ton per day kraft pulp, board and paper mill was awarded to Merritt, Chapman and Scott, which had built 19 paper mills and expansions in the United States. Thirteen years before, the same company had built National's Jacksonville mill. A special Valdosta mill "Construction Fund" of $22,100,000 was deposited with the Marine Midland Trust Co. in New York.

On Oct. 26, 1951, Valdosta's citizens concretely expressed their support of National's plans, by presenting National with the deed for a 275-acre site for the mill. Valdosta's citizens chipped in 50% more than needed to buy the site. The following morning, Mr. Kipnis, wielding a shiny new shovel, dug out the first ground for "the largest industrial investment ever made in this South Georgia-North Florida area."

Local landowners pledged their support to supply the giant mill with 250,000 cords of pulpwood needed yearly. Through a special act of the Georgia state legislature, Lowndes County financed and built a disposal system which will protect neighboring streams and rivers from pollution by local sewage and mill effluent.

With ground broken, construction at the mill site began. It was slow going at first. Building materials were hard to get; the site had to be cleared and graded, and sewers had to be installed; fences and macadam roadways were needed; and 10,000 yd. of hard-top parking area had to be paved. The company built the $6^1/_2$-mile "Eskay"spur (after the initials of National's president) from the mill site to the tracks of the Georgia, Southern & Florida Railroad, and arranged to purchase the Madison branch of the Georgia & Florida. Other phases of preparation work included construction of a project field office and a machine shop; 4125 tons of crushed stone, 50 carloads of sand, and 20,000 bags of concrete were mixed and poured for the foundations of the 1800-ft.-long mill.

After more than a year had passed and $3,000,000 had been spent on the project, the first towering beams of steel were set into place on Feb. 4, 1953. The mill will be completed by the end of 1953.

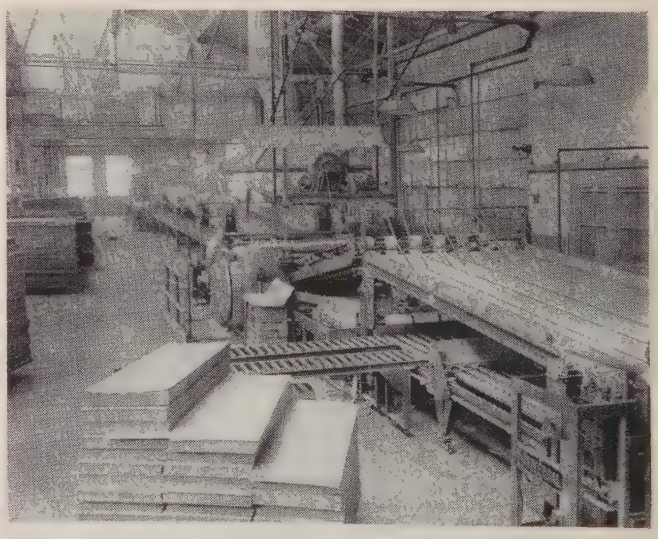
The day that production begins at the new mill, National Container will have the most modern, best equipped, lowest cost producer of kraft paperboard in the entire world. Valdosta's huge 240-in. fourdrinier papermaking machine will run at speeds up to 2000 f.p.m., turning out a minimum of 500 tons per day of kraft pulp and tough, high-strength containerboard. The mill was designed for flexibility of product to include the manufacture of lightweight kraft bag papers. With Valdosta in operation, National's paperboard production will be increased 50%. Because of the exceptional modern design of buildings and equipment, every production facility at the new Valdosta mill can be expanded.

As the Jacksonville mill was the key and springboard for the company's tremendous expansion which began 15 years ago, the new Valdosta mill opens wide the portals of opportunity to National Container Corp.'s second quarter-century now beginning.

LongLac

Terrace Bay is really two stories. One is the mill—a complex of the most modern pulping equipment which annually produces more than 113,000 tons ($16 million worth) of pulp from what was only a few years ago no more than a home for wild game. The other is the growth of a complete community, which offers in a spectacular, natural setting most of the advantages of modern living.

The heart of all this activity and growth, the pulp mill, will complete its fifth year of operation in 1953. It does not impose itself on the attention of the visitor by dominating the town. As a matter of fact, located more than a mile from the townsite, it can be spotted from the residential area only by its smokestack. It is quite the normal thing in a pulp mill



The no. 1 corrugator at the Long Island City plant of the National Container Corp.

town, that the pungent sulphate odor generally reminds visitors and residents of the industrial activity going on. But not so here. The distance from the town, the location of the mill, and the prevailing winds combine to keep the town almost always free of the mill's "long tom."

The mill is approached along a road lined with jackpine, and its clean lines suggest the modern layout and up-to-the-minute machinery it houses. Its rated capacity is 300 tons daily of bleached sulphate pulp, though it has produced substantially more tonnage over extended periods.

Wood arrives at the mill by water after an 80-mile water journey from the woodlands operations at LongLac, Ont. During the Summer months, a steady stream of spruce, jackpine (with some poplar) logs in 8 and 16-ft. lengths floats into the boom area on Hays Lake, the artificial body of water impounded by the Hydro dam. A special jackladder crew keeps the wood moving to the mill along a 3300-ft. rubber belt conveyor said to be the longest such on the continent. At the mill, wood cut into 4-ft. lengths, barked, goes either to the chippers or out to the woodyard, to be stored in one of the six huge blockpiles.

Serving the woodyard is another 2950-ft. endless rubber belt conveyor, which is unusual in that it not only carries wood to the yard but is built so it can return reclaimed wood to the mill when it is needed for operations.

After barking, the wood headed for pulping is cut into small chips in a chipper, and these are temporarily stored in chip bins with a 300-cord (12 hours' supply) capacity before going into the digester building. The digesters are six unlined metal tanks 42 ft. high and 11 ft. in diameter—king-sized pressure cookers designed to cook wood chips at 110 lb. of pressure for a 3-hr. period. The cooking liquor, primarily caustic soda, together with the heat provided by the addition of steam, dissolves the lignin which holds the wood fibers together, and at the end of the cooking period, the resulting "brown stock" is removed to a "blow tank."

After washing, screening, and thickening, the stock moves on to the bleachery, where it passes through a continuous process of five stages. Its color is transformed from a dirty brown to snowy white, and it is ready for the final stage of processing—drying and packaging. The stock is pumped to the headboxes of two Kamyr wet machines, 136 in. wide, which form it into a continuous web of about 30% consistency. After passing through two heavily grooved pressure rolls (which gives the pulp its grooved appearance) it travels through Flakt driers to remove the remaining moisture, and is then cut into sheets, assembled into 500-lb. bales, compressed under a 600-ton hydraulic press, wrapped and loaded for shipment to other corporation mills. Some 7 cars of product leave the mill daily, and only a small amount of finished pulp is ever kept on hand at the mill.

This is an abbreviated description of the highly mechanized mill process, and makes no attempt to describe the necessary steps of making and renewing the cooking liquors, the chemical recovery system, the lime kiln, or the various service functions.

It is perhaps significant that this mill, which was as modern as it could be made at start-up time in 1948, has already seen some extensive improvements. Recently the original bark presses were replaced by a more efficient type. (This equipment squeezes the water from bark preparatory to burning it as fuel in the mill boilers.) Just in its final stages is work on converting the drum barkers from the conventional chain-suspended type to submerged barking, where the logs pass through the barking drums under water. This change makes for a cleaner job and less maintenance on the barking equipment. New equipment has been added to remove more bark from the sewer water, making for a cleaner discharge from the mill.

The recovery system has been improved, too, with the addition of a new lime slaker and a larger hot lime bin. In the pulp mill, a turpentine recovery and storage system has been put in, which makes possible the reclaiming of turpentine and its sale as a by-product whenever the turpentine price level might make this financially attractive. A further step is projected at some future date consisting of equipment to reclaim knots and flat screen rejects, getting from them both fiber and chemicals that are now wasted.

In the bleachery, a new sewer system has been installed to eliminate a serious foaming problem. Equipment has also been put in to permit bleaching pulp to a higher brightness required by some of our outside buyers of pulp. Other changes made have been of a minor nature, but over all they show that the mill is meant to stay in a condition of maximum efficiency and usefulness.

Employment at the mill has grown steadily since the start-up, until last year the average stood at 634. There is some seasonal variation. During the winter months, after ice closes in on the jackladder and the wood is all in the yard for the cold weather and the weather reduces townsite work to a minimum, the total drops under the 600 mark. At the high point, during Summer months, it may touch 700.

All this employment, and the related expenditure of funds, is a sizable segment of the area economy. Payrolls during 1952, for example, poured some $2^1/_2$ million dollars into the region—and it found its way to merchants and businesses all the way from Toronto to Winnipeg.

Even larger amounts, and a wider area, are involved in the procurement of materials for the mill operation. Wood, of course is a major item, and that is provided by the company from its operations centered at Long Lac, Ont. All of the more than 16,500 cords a month used at Terrace Bay is cut and moved by the company's woods organization, which, with its cutting crews, administrative and supervisory force, clerical help, and now the sawmill crews, runs at an average employment rate over 1000.

A wide area of Canada is involved in providing the other raw materials at the mill. Ten cars a month of lime is provided by quarries at Beechville, Ont., and from north of Winnipeg, Man. Salt cake—10 cars monthly—comes from three locations in Saskatchewan. Chlorine comes from Quebec at the rate of 14 cars monthly, and a similar amount of caustic is purchased from suppliers at Beauharnois, Que., and Windsor, Ont. Wrappers come from Spruce Falls, at Kapuskasing at the rate of some 4 cars monthly. Coal is purchased at the rate of 60 cars monthly from a supplier at Fort William. Electric power is provided by the Ontario Hydroelectric Power Commission. Water, treated in the mill plant, comes from Lake Superior—650 million gallons a month.

The railroad through the town is the southern rail artery of the Dominion, and it has been there a long time—more than half a century. It is a busy link in Canada's growing economy, as can be seen from the traffic over its rails. Seven passenger trains daily go through the town, and some 18 freight trains. The weekly freight bills on incoming and outgoing materials are close to $50,000.

To date, the railroad is the only through link, but the highway, on which work has been proceeding steadily, is scheduled to reach Marathon, Ont., 40 miles east some time this Summer. Schreiber, a railroad division point on the Canadian Pacific, is 9 miles west, but the nearest big shopping centers are the Lakehead cities of Port Arthur and Fort William, 140 miles west. In this territory, however, such distances are not imposing, and week-end shopping trips to these places are commonplace among Terrace Bay families. Busses to Lakehead are scheduled four days a week. There is an eagerness about the progress on the highway that indicates to the newcomer a strong desire to see wider horizons for the casual week-end trip.

Terrace Bay is a young town. Its people are young people—the average age is something like 32 among all the company employees. But among them is a strong feeling of pride in the place they have built or come to—the same kind of

pride that must have stirred the ambitions of an earlier generation of pioneers. The enthusiasm they have for doing big things and for boosting their town and company is an inspirational experience.

WYANDOTTE

As a leading supplier of various alkalies, chlorine, and surface-active agents to the pulp and paper industry and as a pioneer in the development of precipitated calcium carbonate for paper coating, Wyandotte Chemicals Corp. has a family of interests in the paper industry.

This interest is apparent in the well-equipped paper laboratory in Wyandotte's new research center. Maintained for research on the use of Wyandotte products in the paper industry, the laboratory includes the more common items of equipment including a supercalender for finishing coated papers. Many instruments for physical evaluation of paper and coatings by recognized TAPPI procedures are also to be found here.

One of the first major accomplishments of Wyandotte research was the development of Purecal M—a paper coating grade of precipitated calcium carbonate which has since gained wide acceptance throughout the industry. Work on special techniques for color preparation at Wyandotte has resulted in a patented high-consistency kneading procedure for reducing adhesive demand—a significant advancement in the development of color preparation methods.

Continuous investigation at Wyandotte is aimed at the improvement of paper coating carbonates. Present emphasis is on the development of special grades of precipitated calcium carbonates giving more smoothness and improved printing qualities to coated papers.

Typical of the processes studied in this section of Wyandotte's new research center are the use of hypochlorite and chlorine for the bleaching of pulp, the evaluation of various alkalies for deinking of wastepaper, and the application of sodium CMC for surface sizing.

Kreelon, Wyandotte's alkylarylsulphonate syndet, has shown great promise in the deinking of newsprint while several of the Pluronics, Wyandotte's new series of nonionic surface-active agents, have been found effective in pitch control and felt washing applications.

In Wyandotte's new research center facilities serving the paper industry are being maintained and expanded from time to time enabling Wyandotte to offer improved service and to be of greater assistance to users of its products.

Wyandotte's new research laboratories have been designed in detail with the object of providing facilities in which Wyandotte's complex program of research may be carried out efficiently. The building design correlates maximum efficiency in use with minimum operational and maintenance cost. This has dictated the layout and materials of construction both of which have been the subject of long and careful study.

The solution of problems of supply of services, ventilation (the building is completely air conditioned for Summer and Winter use) and adaption to particular use will warrant the special attention of the visitor. Future expansion and great flexibility in use have been well provided for.

The new laboratories which cover about one city block are of modern two-story brick construction with a full basement laid out roughly in a T-shape. The new laboratories together with the pilot plant, high pressure laboratory, and Clark St. building comprise the Wyandotte Chemicals Research Center.

Construction of the Wyandotte research laboratories was started in 1951 as one of the projects in a company-wide program of expansion, cost reduction, replacement, and improvement.

General excavation and leveling for the site was begun in January, 1951, on a 5-acre plot just north of the Administration Building of the Corporation on Biddle Ave. at Wyandotte, Mich. It was ready for partial occupancy in January of this year. The completed structure, now in full operation, is the heart of the Wyandotte research center.

The new research laboratories for Wyandotte Chemicals' Research and Development Division

The research building, 172 ft. long and 322 ft. wide, is of modern two-story brick construction with a full basement. A center wing extends back for a half block toward the river from the street entrance. To promote efficiency, the various departments are placed in the wings of the building with the office for each department placed at the point of entry to that wing, resulting in an arrangement which gives department supervisors good control of their departments and at the same time places all such offices close together at a central core for easy interdepartmental discussion and conference.

The administration offices are placed in the north wing with direct access from the lobby. Combined with these offices on the first floor is a meeting room capable of seating 150 persons, or of being divided by folding partitions into two rooms. Storage for chairs and other equipment and a strip kitchen for serving simple refreshments are provided in the meeting room. The meeting room is also provided with separate entrances from the street and parking lot so that it may be used by other company groups without interference with research dept. activities. The second floor of this administrat tion wing houses the market development dept., the paten. attorney's office, and the scientific library and reading room The basement contains the research storeroom, the electron ics laboratory, glass blowing facilities, shop facilities for construction of experimental equipment, and a photographic darkroom. A large-scale pigment laboratory is also located in the basement.

Two of the very important considerations affecting the design of the research building were the desire to have the maximum flexibility within the building itself and the provisions for future expansion without disrupting the use and operation of the building.

Design follows two lines: (1) the concept of modular design in which a standard laboratory becomes simply an assembly of two 10 ft. modules of working space; (2) adaption of the flexibility of use which is a constantly recurring problem in a research building.

This means simply that relocatable partitions in the laboratory spaces give them the flexibility of more sets and make possible the creation of new laboratories or offices almost overnight as space requirements may indicate. These partitions are not "movable" in the sense of sliding or folding walls but trained personnel can take them down and re-erect them quickly without any of the debris or confusion involved in relocating even the simplest plaster or tile partitions.

In Wyandotte's research building, this flexibility has been achieved by designing the laboratory section of the building to a 10-ft. module. Each module includes two exterior windows,

Laboratories may be divided into 10-ft., 20-ft., or larger rooms in units of 10 ft. Research technicians have easy access to the various services they require. Water (hot, cold, and deionized), steam, compressed air, and electricity are piped to convenient locations in each of the laboratories. One pair of service slots is provided in the floor at every 10-ft. interval. These slots are located at the proper positions to service either a wall bench or a free standing center table. By making the slots in pairs, a partition may be placed between the two permitting the servicing of a wall bench on both sides of a partition. Slots not in use are closed with a knock-out concrete panel and floored over.

Partitions between corridors and laboratories are constructed as a double wall with a continuous vertical pipe space extending from the basement to the fan room floor level on the roof of the building. In these double walls on each side of the corridor are provided vertical fume hood exhausts, in general, on 10-ft. intervals. Each fume hood is provided with its own two-speed fans at the fan room level controlled by a switch in the laboratory. These vertical pipe spaces are accessible at each floor by the simple removal of steel panels in the laboratory side.

Main service distribution is carried at the basement ceiling level under corridors and above the first floor corridor ceiling. From these main distribution lines the services are carried out to laboratory service slots and up for connection to laboratory benches. Between the first floor ceiling and the second floor, a pipe space is provided for this piping, accessible from the corridor catwalk for easy maintenance, repair, or extension. By this arrangement additional piping may be run from the basement machine room where all services originate to any laboratory without interrupting the use of the laboratory or running the piping in an exposed condition.

Possibility for future expansion is provided by having all corridors and piping run to the end of the wings. Additional laboratory space may be added to the north beyond the administrative offices, to the east through extension of the center wing, with north and south additions added to that extension, and to the south toward the General Administration Building. Service piping for main distribution is sized to take care of expansion in these directions. Such additions may be constructed without interruption of work in the balance of the building.

Another consideration affecting design was the desire to maintain the operating and maintenance costs of the building at a minimum. In some instances this has resulted in a higher initial cost which will be more than offset over a period of years through the lower cost required for maintenance. Thus, on the partitions between laboratories, a baked-on enamel finish provides corrosion-resistant surfaces requiring no maintenance other than occasional washing for the effective life of the building. Exterior maintenance will be limited to occasional painting of the window sash. Completely filtered air will also decrease maintenance by reducing the amount of dirt which enters the building.

To provide optimum working conditions for the staff and to protect the many delicate instruments used in Wyandotte's research activities, the entire building is air conditioned for both Summer and Winter operations. This was achieved by the high-speed air conduit system which provides two air conditioning units in each 10-ft. module so that regardless of partition the proper number of units are in each room. These units provide heat in the Winter, cooling in the Summer, and ventilation at all seasons. By providing a secondary air system, conditioned air is introduced into each laboratory whenever the fume hood is operating in an amount sufficient to replace the air exhausted through the hood. The system is zoned to compensate for sun heat and it is possible to furnish heat to some rooms and cooling to others at the same time. The air conditioning provides 100% fresh air to each room. There is no recirculation. As a factor in the air conditioning system, double glazing has been used throughout the building because it results in lower heating and air conditioning costs. As an added feature in the effort to provide suitable working environment for the Research and Development Division staff, the building has been equipped with acoustical ceilings to help reduce noise and nerve strain.

Within the new building are special areas assigned for research in such important fields as radioactive tracers, electronics, organic and inorganic chemistry, sanitation and germicides, electroplating, physics, and the entire area of commercial cleaning served by such products as dishwashing compounds, laundry detergents, and metal and industrial cleaners. Also included in the building are special rooms in which the temperature and relative humidity may be maintained at predetermined values to facilitate experimental work and to allow practical testing of various types of packages and containers.

The new research center provides each member of Wyandotte's Research and Development Div. with adequate modern facilities which contribute to his efficiency and satisfaction in carrying out his phase of research.

D. J. Murray

A. W. Plier is now president and general manager of the D. J. Murray Mfg. Co., Wausau, Wis. Mr. Plier joined the company in 1930 having previously been with the Falls Mfg. Co. at Oconto Falls, Minn.

A. W. Plier, D. J. Murray Mfg. Co.

Hercules

The Hercules Powder Co. will cease its production and sale of acid and rennet casein on August 1. Its casein plants at Elroy, Wis., Cambridge and Watertown, Minn., will be closed. Domestic milk prices have made it uneconomical to manufacture casein at costs which will allow it to be sold in competition with imported casein.

The widespread use of fortified size by paper mills is indicated by reports of the conversion of more than half of all size furnish to fortified size within the past two years. Substantially lower size cost per ton of paper and paperboard has been the major factor in the swing to fortified size. Hercules has announced a new paste-fortified rosin size (Pexol 240) which is made from dark rosin.

Hercules has issued a new 12-page booklet on Vinsol, a low-cost dark-colored resin. Copies may be obtained from the company in Wilmington, Del.

G.E.

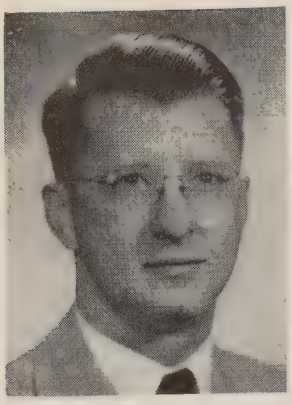
General Electric's welding dept. has been transferred from Fitchburg, Mass., to York, Pa.

Monsanto

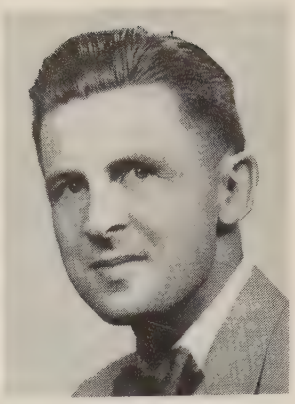
Donald C. Lewis, formerly of the research dept., has joined the sales dept. of the Merrimac Div. of the Monsanto Chemical Co., Everett, Mass. Mr. Lewis' main interest will be in chemicals for the paper industry.

Witco

Continental Blacks, Inc., Division of the Witco Chemical Co., will build a plant at Ponca City, Okla., to manufacture 40 million pounds annually of high abrasion furnace black.



E. A. Berry, Oliver-United Filters, Inc.



I. H. Peters, F. C. Huyck & Sons

This will supplement the production of a similar amount of blacks at Lake Charles, La.

The Witco Chemical Co., 75 E. Wacker Drive, Chicago, Ill., has issued a new bulletin (No. 820) on cork insulation.

CYANAMID

H. Douglas Spruance has been named Arizona Chemical Co.'s technical service representative for the midwest. He will be located in Chicago. For the past 7 years he has been located at the Linden, N. J., research laboratory doing research work on tall oil applications.

WESTINGHOUSE

Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa., has issued a booklet (B-5456) showing how circuit breakers save money.

PERMUTIT

The Permutit Co., 330 W. 42nd St., New York 36, N. Y., has issued a new 24-page booklet (No. 2539A) on Gravity Filters.

LOUIS ALLIS

The Louis Allis Co., Milwaukee 7, Wis., has issued a new bulletin on its line of Wound Rotor Motors, $^1/_2$ to 1000 hp. (Bull. No. 1300). The bulletin covers wound rotor principles of operation and contains performance curves and characteristics that show how these units are suited to particular jobs in industry.

OLIVER UNITED

E. A. Berry has been appointed resident sales engineer to serve the Pacific northwest with special attention to servicing equipment in the pulp and paper industry for Oliver-United Filters, Inc. He will operate out of the Western Sales Div., 2900 Glascock St., Oakland, Calif. He lives in Longview, Wash.

RELIANCE

Reliance Electric & Mfg. Co., 1111 Ivanhoe Rd., Cleveland 10, Ohio, has issued a new booklet on its V–S Jr. adjustable-speed drive.

S. & V.

Following the recent death of Anthony J. Math, Sinclair & Valentine Co., New York, N. Y., has appointed Matt J. Lecky, president, Humphrey H. Desmond and Howard J. Soriano, vice-presidents. Arthur J. Makuken, George J. Warmbold, and Edgar E. Wickoff continue as vice-presidents.

MOVIDAN

The United States Movidan Corp., 863 N. Orleans St., Chicago 10, Ill., has announced a new slime-controlling product (A-36). This chemical was developed in Czechoslovakia during the recent war.

GENERAL DYESTUFF

J. Robert Bonnar has been appointed sales manager of the Dyestuff Div., General Dyestuff Corp., New York, N. Y. Donald E. Marrion has been appointed manager of the Dyestuff Technical Dept.

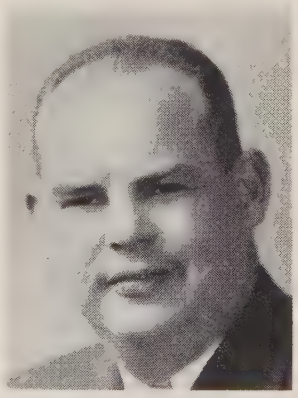
MEAD

George S. Douglas has been appointed division manager of the Escanaba, Mich., mill of the Mead Corp. E. G. Bennett continues as president of Mead's Michigan Div., the Escanaba Paper Co., and the Upper Michigan Power & Light Co. Mr. Douglas joined the Mead organization in 1937.

G. S. Douglas, Mead Corp.

E. G. Bennett, Mead Corp.

M. J. Lecky, Sinclair & Valentine Co.



H. J. Soriano, Sinclair & Valentine Co.

HUYCK FELTS

Irving H. Peters has been appointed manager of field service engineering for F. C. Huyck & Sons, Rensselaer, N. Y. Mr. Peters was formerly associated with Dill & Collins, Flambeau Paper Co., and the New York State College of Forestry.

ARMSTRONG MACHINE WORKS

The Armstrong Machine Works, Three Rivers, Mich., has issued a four-page bulletin on its new Syphon Scoop for use in paper machine drier drainage.

SINDAR

John R. Lyons has been appointed technical representative

of the Sindar Corp., 330 W. 42nd St., New York, N. Y. Sindar manufactures industrial deodorants, germicides, fungicides, and antioxidants.

NORMAN ALPER

Norman Alper, formerly president of M. S. Alper & Son and Hub Paper Stock Co., has resigned and formed a new company, Norman Alper & Co., 111 India St., Pawtucket, R. I., to deal in papermakers' supplies, fibers, and chemicals.

CRANE

The Irving House in Dalton, Mass., has been purchased by Crane & Co. and is now called The Crane Inn.

EAST TEXAS

East Texas Pulp & Paper Co., Evadale, Tex., has received a certificate of necessity from the Office of Defense Mobilization, amounting to $26,700,000, of which 55% was allowed.

SIMPSON-EVERETT

Donald F. McCall has been appointed assistant general manager of the Everett Pulp & Paper Co., Division of the Simpson Logging Co. Mr. McCall has been until July 1 vice-president of the Racquette River Paper Co., Potsdam, N. Y.

WOOD HANDLING ASSOCIATIONS

The United States Dept. of Agriculture, Forest Service, Washington, D. C., has recently issued its 1953 listing of Lumber Manufacturing, Wood Using and Allied Associations.

E. G. HAM

Everett G. Ham, Technical Director of the John A. Manning Paper Co., Troy, N. Y., has been named as one of the ten outstanding members of the American Society for Testing Materials to receive a 1953 ASTM Award of Merit. Presentation of the award was made during the annual meeting of the society in Atlantic City, N. J., at a luncheon in Haddon Hall on June 30.

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

T. J. Nelson, of the technical department of the California and Hawaiian Sugar Refining Corp. of San Francisco, is now assistant to the Coordinator of the By-Products Project of the Hawaiian Sugar Planters' Association, G. W. Aljian.

He is on loan from the California refining organization which is owned by the Hawaiian sugar plantations, and since 1951 has devoted full time as a consultant and job organizer for the by-products work undertaken that year.

Mr. Nelson has been with the C&H refinery since 1926. He has done a variety of original work in the field of raw and refined sugar packaging and handling. His principal interest prior to his Hawaiian assignment centered on paper, its conversion into economical packages, and on the possibilities of using sugar cane bagasse as a source of fiber in papermaking. The latter field is being given first attention in the current Hawaiian study of bagasse and molasses utilization.

OBITUARIES

Arno W. Nickerson

Arno W. Nickerson, Chemical Engineering Consultant, died at his home in White Plains, N. Y., on May 28, 1953.

Mr. Nickerson was born in Brewer, Me., on Jan. 16, 1891, and graduated as a Chemical Engineer from the University of Maine in 1916. Following graduation he was employed by the New Process Gasoline Co., Philadelphia, Pa. During World War I he was employed by the U. S. Chemical Warfare Service. Following the War he became Secretary and Treasurer of Process Engineers, Inc., New York, N. Y., with whom he remained for about 18 years. In 1936 he then became a Consulting Engineer for several paper and paperboard mills, including Robert Gair Co., American Coating Mills, Corn Paperboard Products, Inc., etc.

Mr. Nickerson was buried in Brewer, Me. He is survived by his wife and a son.

For many years Mr. Nickerson was active in the Technical Association of the Pulp and Paper Industry, especially in the field of paperboard and container testing.

Russell H. Bentz

Russell H. Bentz, Vice-President in Charge of Manufacturing at the P. H. Glatfelter Co., Spring Grove, Pa., died of a heart attack on May 13, 1953, at Sturbridge, Mass., while on a vacation trip through the New England States.

Mr. Bentz, who was born on March 11, 1913, at Spring Grove, Pa., became associated with the P. H. Glatfelter Co. in 1935 as a member of the Engineering Dept. After gaining experience for a number of years in the various departments of the mill, he was named Assistant Mill Superintendent, and later was appointed Assistant to the Executive Vice-President. For the past two years Mr. Bentz has served as Vice-President in Charge of Manufacturing.

Russell H. Bentz

In 1935 Mr. Bentz graduated from Lehigh University with a B.S. in Chemical Engineering. Prior to that time he had graduated from The York Collegiate Institute and had been awarded a scholarship to Lehigh University by the P. H. Glatfelter Co. as a result of his excellent scholastic record. In recent years he pursued a supplementary course of study at the York Technical Institute of The Pennsylvania State College.

In addition to holding memberships in the Technical Association of the Pulp and Paper Industry and The Pulp and Paper Mill Superintendents' Association, Mr. Bentz was also a member of The Society for the Advancement of Management and of The American Management Association.

Adam Cunningham

Adam Cunningham, Chief Engineer of the Paper Division of Price Bros. & Co. Ltd., Kenogami, Que., died on April 19, 1953, of a heart attack.

Mr. Cunningham was born in Edinburgh, Scotland, on Aug. 23, 1897, and graduated in machine design from the University of Edinburgh in 1923. Following graduation he was a draftsman for MacTaggart & Scott, Ltd.

In 1924 he joined Price Bros. & Co. Ltd. at Kenogami, Que., as an engineer. In 1936 and 1937 he was an engineer for the Ontario Paper Co. at Thorold, Ont., and returned to Price Bros. in 1937 as Chief Engineer.

Mr. Cunningham was a member of the Technical Association of the Pulp and Paper Industry.

LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel, and Events

Kalamazoo Valley

The regular April meeting of the Kalamazoo Valley Section of TAPPI took place in the Hotel Harris in Kalamazoo. The subject of the meeting was "Sizing." There was an afternoon and evening session. There were about 150 members present. Thomas Luey, the chairman, presided at each session. The speakers were introduced by Reginald Hurst, the program chairman.

The first speaker of the afternoon session was Ralph Kumler of the American Cyanamid Co., his subject being "Recent Developments in the Rosin Sizing of Paper."

He said that although much good work had been done on rosin sizing it needed to be gathered together. He proposed to devote his talk to doing this as far as time would permit.

Before he started he spoke of the recent developments in fortifying regular rosin size by the incorporation of three extra hydroxyl groups. He stated also that a material was available that would successfully size paper at pH 8 to 9. It is expensive and applicable primarily to specialties.

The first work discussed was Ekwall and Brunn's study of alum and rosin size. They first cast a film of rosin in benzene solution on the surface of water. A glass slide was moved across the surface, contracting the film, thus setting up a resistance so the force to rupture the film could be measured. The same film was cast on the surface of the alum solution and the strength to rupture the film measured. It was found that film formed was more compact and the force to rupture the film was greater. It was deduced from this that the alum served to orient or fit the rosin molecules together.

The film was skimmed off and analyzed and found to contain aluminum monoresinate. Aluminum diresinate was found in precipitated size; the monoresinate was present in the presence of excess alum.

The next work discussed was the behavior of rosin-alum precipitates in the presence of foreign materials such as chlorides, sulphates, lignosulphonates, citrates, oxalates, and ferricyanides. Most of the inorganic anions except chlorides decrease the electrophoresis mobility of the trivalent alum ion, which tends to help sizing. The presence of chloride, ferricyanide, and organic anions tends to reverse the positive charge of the alum and decrease sizing.

It was also stated that if paper, 65% dry, be heated for 1 min. without loss of moisture at 100°C., the size value doubles if Delthirna size be used.

R. W. Kumler, American Cyanamid Co.; R. J. Pavlin, E. I. du Pont de Nemours & Co.; R. H. Hurst, Kalamazoo Vegetable Parchment Co.; J. P. Bainbridge, Jr., Monsanto Chemical Co.; A. T. Luey, Sutherland Paper Co.; R. T. Trelfa, Watervliet Paper Co.; J. A. Dean, Michigan Paper Co.; and H. O. Ware, Hercules Powder Co.

The size test is better if final heat is at 110° instead of 50°. Three possible equations were given for the reaction of size and alum.

$$Al_2(SO_4)_3 + 6NaR + 2H_2O \rightarrow 2Al(OH)R_2 + 3Na_2SO_4 + 2HR \quad (1)$$

$$Al_2(SO_4)_3 + 6NaR + 4H_2O \rightarrow 2Al(OH)R_2 + 3Na_2SO_4 + 4HR \quad (2)$$

$$Al_2(SO_4)_3 + 2NaR + 2H_2O \rightarrow 2Al(OH)(SO_4) + Na_2SO_4 + HR \quad (3)$$

The next paper of the afternoon was given by R. J. Pavlin of the Du Pont Co., on the subject of Quilon.

Quilon is stearato chromic chloride. Quilon in solution ionizes and is water soluble when hot. The chromium group remains on the surface of the paper while the stearate penetrates. Heat is needed to do this.

Quilon is not a beater or headbox additive, but works well at the presses or size tub at a rate of $^1/_2$% based on the weight of the paper.

The solution is prepared by adding it with stirring to water at 120°F.

Its properties are: (1) no change in color, finish, or porosity; (2) increases penetration resistance to water (duck's back effect); (3) works best on unsized stock; (4) aids wet-strength resins and starches; and (5) paper is not slippery and printing qualities are improved.

Mr. Pavlin's paper in full follows the Section report.

The last paper of the afternoon was given by Harris Ware of Hercules Powder Co., on the subject of CMC (carboxymethyl cellulose).

Mr. Ware stated that although CMC had possibilities as a sizing agent, he proposed to talk about its structure and general possibilities.

Papermaking in the past has largely been a mechanical proposition, but the field is wide open to chemical development as only a small fraction of the strength of the fiber can be developed by mechanical means. Work has indicated that CMC may be of assistance along these lines as it can help the linkage of the cellulose molecules by bringing them chemically close together rather than just by physical felting.

CMC is a chemical hydrator. In terms of burst, 1% CMC cuts the beating time in half. CMC plus 5% caustic requires only 28% of the original power. As it is a power not a fiber substitution the cost of CMC makes its value in this regard an academic question.

As a calender treatment on board at a rate of $^1/_2$ lb. to 10,000 ft., a 13 to 20-lb. ink saving resulted.

John Bainbridge of the Monsanto Co. gave the final paper of the evening. His subject was "The Evaluation and Significance of Rosin Sizing."

Mr. Bainbridge limited his discussion to engine sizing. For the purpose of his talk he defined sizing as rendering paper impervious to water or aqueous liquids.

If the paper is unsized, the fibers and paper surfaces are uncoated; the water will pass through. If size be added properly precipitated and subjected to heat, a water-resistant coating and film is formed and the water penetrates slowly.

He defined a good size test as one which will show a known difference. To evaluate the various tests, eight sets of sheets, sixteen sheets to a set, were all made up under the same conditions except for degree of sizing.

1. The ink flotation test give a decided difference in all cases.
2. Lactic acid penetration gave good results.
3. Sugar-dye test not so good as some of the others.
4. Valley size test was quite sensitive to differences.
5. Ferric chloride-thiocyanate test was more sensitive than the sugar-dye test, but gave difficulty.
6. Twenty per cent lactic acid penetration gave good results on hard sized board.
7. Dry indicator, fluorescent, and Cobb tests gave difficulty in the higher ranges.
8. Curl test was good in mill practice; more sensitive than dry indicator test.
9. Currier size test not sensitive at high range.

May Meeting

The regular monthly meeting of the Kalamazoo Valley Section of TAPPI was held May 7, 1953, at the Hotel Harris in Kalamazoo. About 50 members were present. Thomas Luey, Section chairman, presided.

The meeting was devoted to the presentation of the gist of their theses by the members of the senior class of the pulp and paper curriculum at Western Michigan College. The list of men and their subjects was as follows:

Kraske, David J., Rumford, Me., "The Influence of Beating of Pulp on Fiber Length and Fiber Length Distribution." (Part II.)

Larson, Russell I., Norway, Mich., "A Study of Methods Used to Determine Fiber Length and Fiber Length Distribution by Means of the Microscope."

Winn, James W., Taylorville, Ill., "The Influence of Varying Amounts of Noncellulose Fibers on Properties of Handsheets."

Witters, Robert J., Kalamazoo, Mich., "The Effect of Locust Bean Gum on Strength Characteristics of Handsheets. A Study of the Influence of Alum or Hydrogen Ion Concentration."

Yankoviak, Frank L., Sheboygan, Mich., "The Influence of Varying Degrees of Sizing and Varying Quantities of Hardwood Fibers on the Printability of Bleached Sulphate Handsheets, When Moisture Setting Inks Are Used.

Haque, Md. Mozammel, Pakistan, "Size Tests Applicable to Writing Surfaces versus Aqueous Inks."

Janes, Raymond L., Grand Rapids, Mich., "Color-fastness of Modern Paper Sizing Materials in Presence of Iron."

Uhl, Allen E., Monroe, Mich., "Quantitative Determination of Titanium Dioxide in Paper Without Ashing."

Dunlap, James E., Hammond, Ind., "Degree of Finish versus Printing Quality."

Drexel, Richard J., Valdosta, Ga., "Influence of Additives upon Viscosity of Concentrated Deinking Waste."

Maves, Kenneth L., Tecumseh, Mich., "Supercalendering Variables I."

Raymond Janes, TAPPI award winer for the outstanding student, introduced his classmates.

JAMES A. DEAN, *Secretary*

The Senior Class in Paper Technology at Western Michigan College: D. J. Kraske, F. L. Yankoviak, R. I. Larson, J. E. Dunlap, R. J. Drexel, M. M. Haque; A. T. Luey, Sutherland Paper Co.; R. L. Janes, K. L. Maves, J. W. Winn, R. J. Witters, and A. E. Uhl

Stearato Chromic Chloride as a Sizing Agent for Paper

R. J. Pavlin

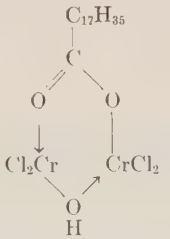
IN PREPARING to discuss a subject relating to such a complicated and historic topic as paper sizing, it was my natural impulse to try to develop some practical and theoretical knowledge of sizing as presented by the past and present papermakers. In reviewing literature references and technical papers published over the past 20 years or so, two generalizations continue to make their appearance in one phase or another, namely, that sizing may be defined as a method of modifying paper products to render them resistant to the penetration of water and aqueous liquids; and, secondly, that water-dispersed sizing agents normally consist of two parts: (1) the polar, water-soluble portion, and (2) the nonpolar water-insoluble, water-repellent portion. It is this second generalization that will constitute the background for the major portion of my talk, as I would like to acquaint you with a new sizing agent which is water soluble instead of water dispersible, but yet is bifunctional, possessing both the polar and nonpolar components mentioned, and is capable of developing water resistance. This material chemically is stearato chromic chloride, a Werner complex, and is trade-marked "Quilon" (U. S. pat. 2,273,040).

There is a rather romantic story to relate concerning the discovery of Quilon at the Cleveland Research Laboratory of Du Pont's Grasselli Chemicals Dept. In 1940, two research chemists were conducting studies with chromyl chloride and, as fate would have it, one day a dilute solution of chromyl chloride was spilled on a piece of old filter paper which had been around the laboratory for some time. As a matter of curiosity, the solvent was dried off on a steam plate to see if the chromyl chloride would set the paper on fire. But nothing happened, so the paper was disposed of in the nearest sink. However, it was at once noticed that the old piece of filter paper was quite water repellent. A new piece of filter paper was immediately treated with chromyl chloride, but only minor water repellency developed. Then the "spark of genius" made its appearance. It was theorized by one of the chemists that the old filter paper had accumulated an oily film from the Cleveland atmosphere; the hexavalent chromium oxidized the oil to the carboxylic acid; the resultant trivalent chromium coordinated with the carboxyl group and the cellulose of the filter paper; and the complex made a water-repellent surface. Further research and development led eventually to the synthesis of a series of Werner-type chrome complexes, among which "Quilon" stearato chromic chloride possessed the best sizing properties.

Perhaps it would be helpful at this point to very briefly mention the Werner theory and discuss how it is possible to make a complex such as Quilon, paradoxically both water soluble but yet capable of developing water repellency.

According to the Werner theory, an atom may combine with other atoms, radicals, or molecules through both primary and secondary valences and thus build up more complex molecules. The number of such groups an atom can hold by secondary valence is termed its coordination number, which in the case of chromium is six.

Examination of the stearato chromic chloride complex and investigation of its reactions will demonstrate this theory.

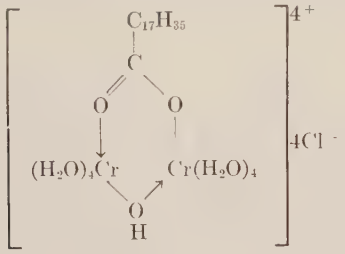


Stearato Chromic Chloride

R. J. PAVLIN, Industrial Product Development, Grasselli Chemicals Dept., E. I. du Pont de Nemours & Co., Wilmington, Del.

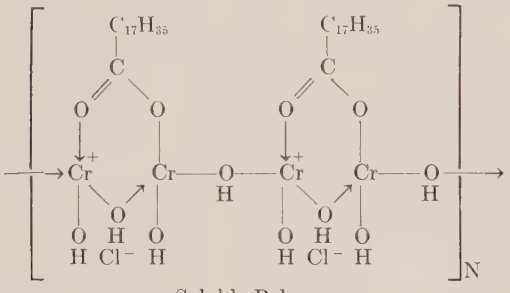
This is probably the best structure which can be used to represent stearato chromic chloride as it exists in the commercially manufactured commodity. The molecule or complex is composed of two distinct components, the nuclear chromium atoms or polar "head" and the functional stearic group or nonpolar "tail," very much like the modern synthetic detergents. Like detergents, this complex is water soluble, the stearate group being held within the coordination sphere of the chromium atoms.

In reality, Quilon, as manufactured, is an isopropanol solution of stearato chromic chloride with a small amount of water present. Thus, Quilon, as received, or when diluted with water in preparation for application to a surface, should be diagrammed as follows; indicating ionization has taken place:



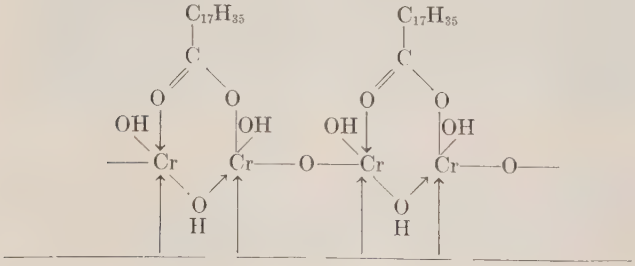
Ionized Stearato Chromic Chloride

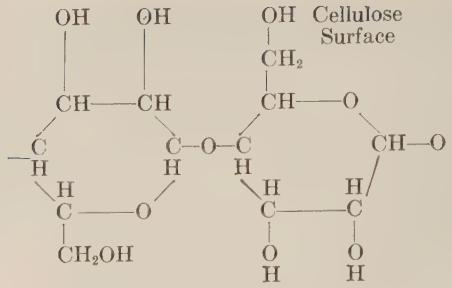
With aging or heating dilute aqueous solutions of "Quilon" stearato chromic chloride, partial olation takes place with formation of Cr—OH—Cr linkages. If this olation does not proceed too far, the product remains soluble, though presumably of fairly high molecular weight.



Soluble Polymer
(omitting coordinated water)

Assume now that the partially olated but still water-soluble complex is applied to a negatively charged surface containing hydroxyl groups, as cellulose, or other polar groups and the treated material is heated to the range of 200 to 250°F. The heat effects more complete olation, coordination of the complex with the polar groups of the surface, and finally oxylation to form Cr—O—Cr linkages. This leads to formation of an insoluble complex, with the polar nuclear chromium ions attached to the negatively charged surface, and with the nonpolar stearate group oriented away from the surface. The following diagram illustrates the proposed mechanism of reaction of "Quilon" stearato chromic chloride with cellulosic surfaces.





Proposed Reaction with Cellulose

The hydroxyl groups of the cellulose are shown here as coordinated with chromium, having displaced water molecules previously held. It is also conceivable that these hydroxyl groups would associate with the primarily held hydroxyls of Quilon and with application of heat, dehydration would occur to form ether linkages.

It can be seen then that if an oriented monomolecular film of Quilon could be deposited on cellulosic fibers in the form of a paper surface, the hydrophobic tails would be oriented upward and water repellency should result. This is the phenomenon found to occur in experimental and commercial applications of Quilon.

Three principles have been presented in the theory of the stearato chromic chloride reaction mechanism, and they should be carried over into the realm of commercial application in order to derive maximum benefits from our treatment. These principles would be (1) Quilon is water soluble and water plays an important part in the reaction mechanism; (2) modification of a surface containing polar groups results in an oriented monomolecular film of water-repellent stearate groups, and (3) heat is essential to insolubilize or polymerize the complex. Briefly, then, application of Quilon would involve three steps: (1) preparation of a dilute water solution of Quilon; (2) application of the diluted Quilon to a paper surface; and (3) heating the surface. The papermaking operation does permit these three steps to be accomplished.

First of all, a point of application must be found where a dilute water solution of "Quilon" stearato chromic chloride can be applied to a paper surface. Commercially, this would be feasible at the wet end of the paper machine at a point prior to entry of the paper web into the drier section; at the size press or tub; or at the calender stack via water box. It has not been found economically attractive to add Quilon at the beater or headbox. Application of Quilon at the size press or at the wet end would allow the treated sheet to be dried adequately, but calender stack application permits only marginal drying. Two distinct methods of solution preparation are suggested to accommodate these separate drying conditions.

From experience, it has been determined that approximately 0.5% Quilon, based on the weight of paper, is usually required to develop optimum water-resistant properties, taking unbleached kraft as an example. The concentration of the solution can be calculated, taking into account the amount of solution to be picked up on the paper at the point of application. Normally, solutions of Quilon are applied at concentrations below 5%. Standard solution preparation for wet-end or size press application involves the simple addition of the prescribed amount of Quilon to water at room temperature with agitation. To offset acidity and thus avoid tendering of the paper, neutralizing agents are normally added to the dilute solution. A water solution of urea, sodium formate, and formic acid is conventionally used, although hexamethylene tetramine is a preferred alternate where the treated paper would not be used for food wrapping. After the addition of the neutralizing materials, the solution of Quilon is ready for application.

In a calender stack application of Quilon, a situation is encountered where the paper would normally not be heated

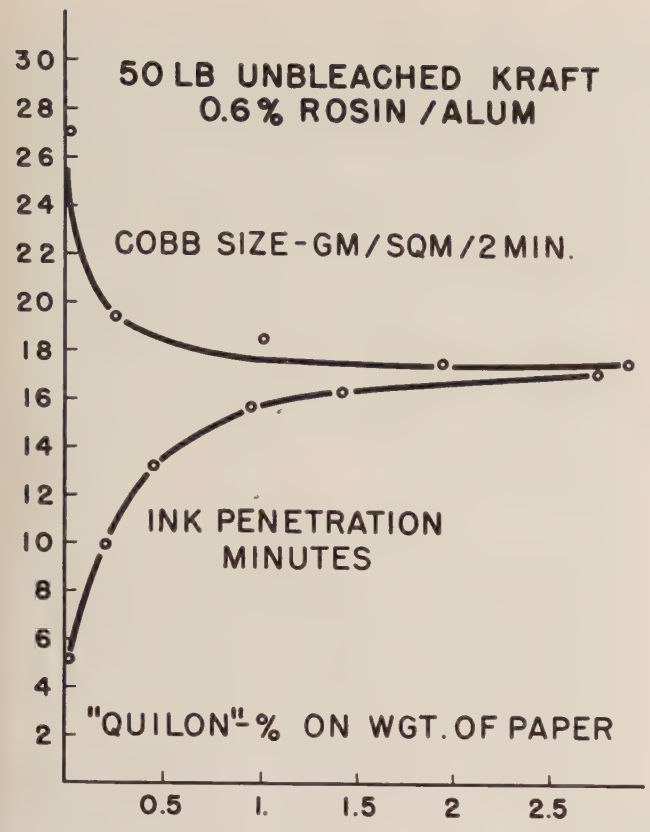


Fig. 1

sufficiently after treatment with a solution at the water boxes. In this instance, our solution preparation method requires the application of heat during the preparation cycle.

The application of sizing solutions at the size press or tub and calender stack is not new to the paper industry, and I don't believe that any special discussion is required as far as techniques to use with Quilon. The major precaution which must be taken is to keep the treating solution at a temperature below 120°F. This is normally not a problem at the size press, but may be a problem at the calender stack, unless cooling facilities are available.

You are probably wondering what degree of success has been experienced in applying Quilon at the wet end of the machine. The technique suggested involves application of a dilute Quilon solution on the wet paper web by spraying at a point where the web is entering the drier section. Also, trials have been conducted applying Quilon on the wire at a point prior to the suction boxes, but with only moderate success. If it were absolutely necessary to use the wet end for application and spraying was not an acceptable device, possibly a water box or two could be rigged to apply the solution at the smoothing press. Generally speaking, however, wet end application is not used extensively and most applications of Quilon are carried out using the size press.

Thus far, this discussion of application of Quilon has been restricted to the paper machine. Needless to say, Quilon could be also applied using off-machine coating equipment or converting equipment, providing, again, that attention is given to uniform application of the solution to the paper surface and to adequate drying.

The properties of paper treated with "Quilon" stearato chromic chloride will probably be of greatest interest to you. Treated with Quilon, paper normally has the same appearance as untreated stock. Color, stiffness, porosity, feel, and strength remain essentially unchanged. It is almost impossible sometimes to detect treated paper from its untreated counterpart without actually checking water resistance or analyzing the paper itself for chromium retention. The water resistance contributed by Quilon is first evidenced when the

Table I. Water Resistance of Various Pulps Treated with Quilon

Handsheets—35 lb. basis

Pulp	Water drop test, sec. to wet— Unsized	Sized
Unbleached pulp	120	120
Bleached kraft	180	120
Bleached sulphite	180	180
Soda	300	180
Groundwood	300	120

Note: Quilon retention 1/2% on dry weight of pulp, except groundwood at 3/4% Quilon.

treated paper is sprayed with water. The water droplets roll off, indicating a high angle of contact between the water droplets and paper surface. The degree of water repellency can be established by holding a sheet of paper at a 45° angle and allowing a drop of water to roll down the paper surface. The paper would be 100% water repellent if the drop rolls completely off without leaving any trail. The paper would be 50% water repellent if the drop would leave its trail about one-half wetted. A range of values can be established arbitrarily using the pattern the water droplets leaves rolling down the sheet as a guide.

If paper treated with Quilon is allowed to remain in contact with water long enough, penetration slowly begins to take place. The rate of penetration is, of course, a measurement of the sizing contributed by Quilon. Table I illustrates sizing data accumulated on various papers treated at 0.5% retention of Quilon.

A water drop test variation was used to test the water resistance contributed by Quilon on these various papers. The time was noted for a drop of water applied to the surface to wet the surface. This wetting was the type noted when the droplet was flicked from the surface and was started to get a slight clinging effect. A 90-sec. water drop test would be equivalent to giving 100% water repellency. There seems to be some indication that Quilon is more effective per unit retention when applied to unsized papers than on papers sized with rosin/alum.

Figure 1 illustrates Cobb size and ink penetration values obtained on a 50-lb. unbleached kraft containing 0.6% rosin/alum, at various retentions of Quilon. Maximum sizing

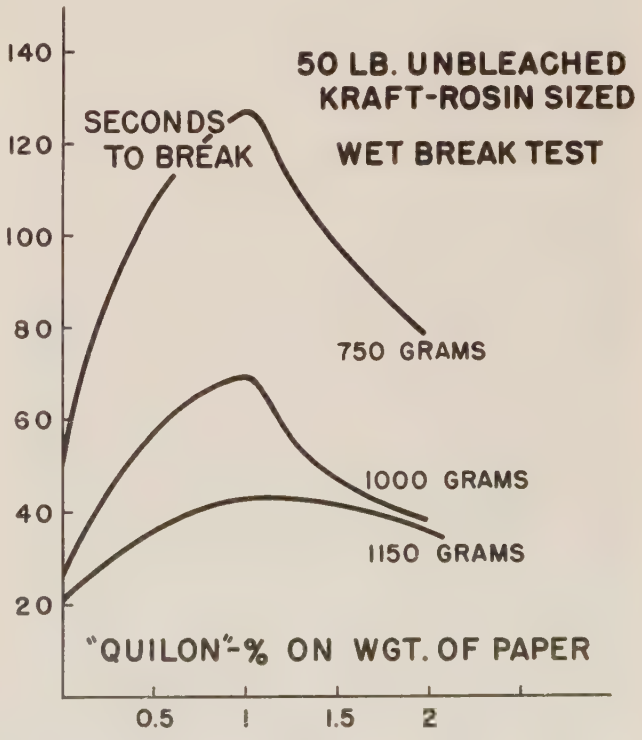


Fig. 2

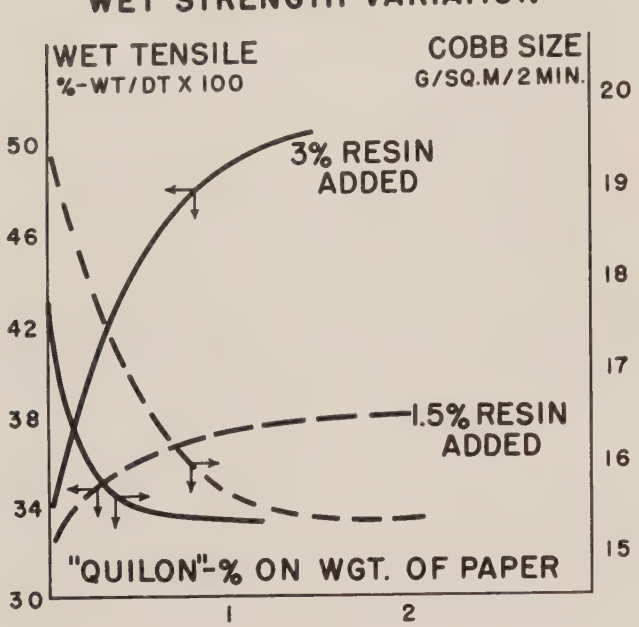


Fig. 3

efficiency both by Cobb and the ink penetration measurements is obtained at a point between 0.5 and 1% Quilon. Above 1% the curve flattens out with no apparent value received for the added retention of Quilon. Again, in comparing sizing data accumulated on unsized and sized papers of various types, there is a trend toward better sizing per unit retention of Quilon on the unsized papers.

Figure 2 illustrates a wet break test conducted with various weights on 50-lb. basis weight kraft treated at various retentions of Quilon. Weights of 750, 1000, and 1150 grams were used. Here peak water resistance is obtained at 1% Quilon, but then the value drops off sharply as we approach the 2% retention. The loss of wet break strength might be attributed to two factors: first, when an excess of Quilon is applied to paper, part of the complex becomes unoriented as it seemingly has no place to go. The unoriented Quilon may have the chromium or polar portion of the molecule oriented outward which would act to attract water rather than repel it. Secondly, excessive retentions of Quilon can have a lubricating effect on the fibers, resulting in lower dry and wet-tensile strengths.

Figure 3 illustrates wet-tensile strength and Cobb size values developed on a 50-lb. kraft paper modified with a cationic wet-strength resin and treated at various retentions with Quilon. Two sets of curves are present, one where 1.5% resin was added to the pulp prior to sheet formation, and the other curve for 3% resin added. These data would indicate that some synergism exists between the Quilon and resin, particularly at the higher resin addition. What actually happens to give this added benefit is obscure. "Quilon" stearato chromic chloride is applied to the paper containing resin before the resin is completely polymerized. Thus, it may be possible for Quilon to cross link with the resin itself and form a more insoluble fiber bonding agent. Also, perhaps Quilon reacts with excess resin mechanically carried by the pulp to convert it into an active ingredient or constituent for wet-strength development. The water resistance of the paper is is also substantially increased. The paper treated with Quilon alone, that is with no resin present, had a Cobb size value at 1/2% retention of Quilon of about 19 grams per square meter for 2 min. Thus, the combination of Quilon with high resin addition can result in paper possessing exceptionally high wet-strength properties as well as water resistance.

Similar data patterns were developed with a variety of the wet-strength resins commercially available, including both cationic and anionic types. It is interesting to note that these high wet-strength values are in evidence even after the papers are soaked for 72 hr. in water. This soaking period should allow complete penetration of the paper and thus overcome any retention of dry tensile which might be preserved by the water resistance contributed by Quilon.

Since there are many materials currently used in the paper industry that contribute excellent water-resistant properties, perhaps the advantages associated with employment of Quilon should be presented.

1. "Quilon" stearato chromic chloride is easy to apply, being water soluble. Stability characteristics are ordinarily good under most mill conditions.
2. The sizing contributed by Quilon is nonfugitive, because the complex itself is anchored chemically to the paper.
3. Only a small amount of Quilon is required to develop high sizing, for example, 0.5% on kraft paper. This would amount to approximately 0.6 lb. Quilon for 10,000 sq. ft. of paper surface.
4. Quilon can be applied to acid, neutral, or alkaline papers for development of water resistance.
5. Uniform sizing is obtained during all periods of the year, providing proper retention of Quilon is maintained.
6. Since only small amounts of Quilon are used, and application takes place at the size press, there is normally no interference with the function of the paper machine. Paper surfaces treated with Quilon are not slippery and thus rewinding is not a problem.
7. The printing qualities of treated papers are unaffected; in some instances improvement is noted because of the organophilic nature of the surface.

Since many materials are applied to paper at the size press to add specific characteristics to the paper, you may be interested in the performance of "Quilon" combined with these commodities. "Quilon" is compatible with many of the common tub sizing materials, for example, chlorinated or enzyme-converted starches, glue or gelatin, methylcellulose, and a few of the water-soluble gums. "Quilon" would not be compatible with alkaline starches, casein, sodium alginate, sodium carboxymethylcellulose, or complex phosphates.

Generally speaking, Quilon is compatible with materials stable under acid conditions, and those that do not liberate polyvalent anions. Where the tub sizing additive is hydrophilic, for example starch, the water resistance contributed by Quilon is lowered, and some of the Quilon will interact with the starch.

Before closing, mention of two other important functions Quilon performs may interest you. The thought has been presented that treatment of paper with Quilon results in the formation of an oriented monomolecular film of stearate groups. Since the stearate is relatively inert chemically, surfaces treated with Quilon should resist adhesive forces such as imposed by pressure-sensitive tapes, adhesives, tacky products, etc. Actually, this release characteristic of Quilon is a reality. Papers treated with Quilon can be used as separator papers in the rubber industry, as bakery pan liners, for lining packages for sticky or tacky articles, or as a back size for pressure-sensitive tapes. I shall not dwell on this particular subject, since it does not pertain specifically to sizing, but I did wish to mention this interesting property, as it is a natural outgrowth of treatment with "Quilon" stearato chromic chloride.

The other function that Quilon performs which may be of some interest is the insolubilizing action it exhibits on water-sensitive coatings or adhesives. I have previously mentioned that Quilon would react with starch when applied as a tub size. This does occur to a degree, but unfortunately the insolubilization is not sufficient to raise the water resistance of the starch coating to the casein level. Casein coatings may be rendered water repellent with an after-wash of dilute Quilon. Quilon is also a very effective insolubilizer for polyvinyl acetate emulsion and polyvinyl alcohol, and also of adhesives or coatings based away from these materials.

SUMMATION

"Quilon" stearato chromic chloride is a Werner-type com-

plex that can be applied from water solution to surfaces containing polar groups, and after heating, chemical reaction takes place with the development of water repellency or water resistance. Paper treatment with Quilon can be easily accomplished as a surface treatment on the paper machine or with off-machine equipment. Water-resistant properties are developed on most types and varieties of paper and without adversely affecting appearance, strength, or texture. Exceptional water resistance and wet-strength properties can be achieved on papers modified with high wet-strength resin loadings at the beater. The sizing properties contributed by Quilon are nonfugitive and are not adversely affected by general aging conditions. Quilon is compatible with many of the conventional tub sizing agents such as starches or glues. Quilon can also be used for the development of release characteristics on paper and as an insolubilizing agent for water-sensitive adhesives or coatings.

Delaware Valley

The April 23, 1953, meeting of the Delaware Valley Section, was a dinner meeting held at the Engineers Club, Philadelphia, Pa. Chairman Harold Brill opened the meeting.

Al Hartley, chairman of the Teller's Committee, reported that Section officers duly elected for the year 1953–54 were:

Frank J. Lovegren, P. H. Glatfelter Co., chairman
Emil R. Padavic, Container Corp. of America, 1st vice-chairman
Ed Molin, Glassine Paper Co., 2nd vice-chairman
Phil E. Nethercut, Scott Paper Co., treasurer
C. R. Calkins, Riegel Paper Corp., secretary
Harold C. Brill, Pigments Dept., Du Pont, Executive Committee
John P. Weidner, Container Corp. of America, Executive Committee

Mr. Hartley also extended the Section members an invitation to attend the meeting of the Superintendent's Association, Stacy-Trent Hotel, Trenton, N. J., May 15–16, 1953.

Mr. Brill announced that the next Section meeting was to be on May 28, the "Edward J. Albert Award Program." Judges for the competition are to be: C. A. Shubert, Mead Corp., Philadelphia; W. B. Morehouse, Nopco Chemical Co., Harrison, N. J.; and Donald Bradner, Du Pont Development Dept., Wilmington, Del.

Chairman Brill extended the thanks of the Section for the taking of pictures to K. S. Whisler, P. H. Glatfelter Co.

Frank Lovegren thanked the Section for the honor bestowed him by electing him chairman and pledged his best efforts in carrying out the duties of the office.

H. H. Dana, Curtis Publishing Co.; H. T. Nicolson, National Vulcanized Fibre Co.; E. R. Smith, Union Mills Paper Mfg. Co.; L. P. Thompson, Personal Products Corp.; W. H. Moon, National Paper Corp.; Malcolm Lowe, Jr., Lowe Paper Co.; C. R. Calkins, Riegel Paper Corp.; H. C. Brill, E. I. du Pont de Nemours & Co.; F. J. Lovegren, P. H. Glatfelter Co.; and E. C. Molin, Glassine Paper Co.

Part of the group attending the April meeting of the Delaware Valley Section

Mr. Lovegren introduced the panel moderator, L. P. Thompson, Production Manager, Paper Div., Personal Products Corp., Milltown, N. J. The subject, "Paper Defects," was discussed by Mr. Thompson and then by the panel members in turn. Then a lively discussion followed with questions put to the panel from the floor. Panel members were Mr. Thompson and: Howard H. Dana, Manager, Paper Div., Curtis Publishing Co., Philadelphia, Pa.; Hugh T. Nicolson, Superintendent, National Vulcanized Fibre Co., Yorklyn, Del.; Ellman R. Smith, Mill Manager, Union Mills Paper Manufacturing Co., New Hope, Pa.; Willard H. Moon, Plant Manager, National Paper Corp. of Pennsylvania, Ransom, Pa.; Malcolm Lowe, Jr., Superintendent, Lowe Paper Co., Ridgefield, N. J.

(A detailed report on the talks and discussion will appear in a later issue of *Tappi*.)

Mr. Brill closed the meeting with a rising vote of thanks to Moderator Thompson and Panel.

Attendance was about 100.

FRANK J. LOVEGREN, *Acting Secretary*

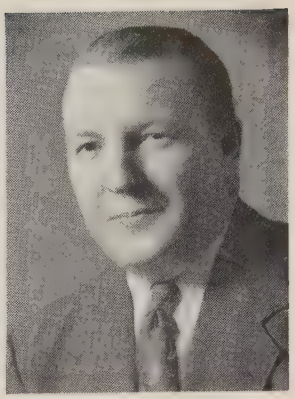
Southeastern

The last Spring meeting of the Southeastern Section of the Technical Association of the Pulp and Paper Industry was held at the General Oglethorpe Hotel in Savannah, Ga., on May 8 and 9, 1953. The attendance at the meeting was 154 persons. A social hour preceded the dinner.

The business meeting followed the dinner and included the annual election of officers. Karl Guest, Chairman of the Nominating Committee, presented the slate of officers suggested for the coming year. Those suggested were Malcolm B. Pineo of the Brunswick Pulp & Paper Corp. for chairman, C. H. Rogers of the Sonoco Products Co. for vice-president, and George Scofield of Rayonier, Inc., for treasurer. They were elected unanimously. The gavel was then presented to Mr. Pineo by the outgoing chairman, Glenn C. Kimble, in a short ceremony. Mr. Scofield presented the financial report for the year, which showed a membership of more than 200 and a solvent treasury. T. T. Dunn, vice-president of Union Bag & Paper Corp., was introduced and then James Lientz gave a message from TAPPI praising the growth and handling of the Section by its officers. G. W. E. Nicholson, vice-president of Union Bag & Paper Corp., then addressed the group and welcomed them to Savannah. The meeting was then turned over to Reavis C. Sproull, the program chairman.

The program consisted of four speakers who presented material of interest to the audience. The first speaker was John Morris of the Union Bag & Paper Corp., who spoke on "Interpretation of Cooking Charts from Direct Steamed Kraft Digesters." The second paper, "Rapid Determination of Black

M. B. Pineo, Brunswick Pulp & Paper Co.; Chairman, Southeastern Section



G. K. Storin, Niagara Alkali Co.; Chairman, Western District, Empire State Section

Liquor Solids," was delivered by Peter B. Borlew and was written by Mr. Borlew and S. Jerome Lancaster both of the Container Corp. of America. The third paper was given by Thaxter W. Small of Sprout, Waldron and Co. entitled "Semichemical Pulping, South Georgia-Florida." The fourth paper entitled "Georgia Forests and the Pulp and Paper Industry" was given by E. L. Demmon, Southeast Forest Experiment Station.

J. R. Lientz of the Union Bag & Paper Corp. then gave a brief summary of the equipment and operations at the company's Savannah mill. The following morning was taken up by a guided tour of the mill.

Empire State (Northern District)

The successful 1952–53 season was brought to a close with a Ladies Night held on Thursday, May 14, 1953, at the Hotel Woodruff, Watertown, N. Y. The program for Ladies Night was under the direction of William G. Garlough, Knowlton Bros.; John H. Treadwell, Treadwell Supply Co.; and Paul R. Anderson, St. Regis Paper Co.

In addition to the pleasure of having the ladies with us we were entertained by a variety group headed by Stan Block who does an act consisting of impersonations, pantomime, and fast patter. He was ably assisted by Laurita Derrigo, the semiclassical vocalist who finished second at the local Horace Heidt show a few weeks ago, and by Carolyn Wade, a local vocalist.

Some of the ladies were more fortunate than others and those ladies took home with them valuable prizes won by simply having the right number at the right time.

The culmination of the enjoyable program was the dancing and sociable getting together of the TAPPI-men and their ladies for a worry-free night.

Richard J. Murtaugh, *Secretary*

Empire State (Western District)

The Empire State Section, Western District, met in the Washington Room of the Park Hotel in Lockport, N. Y. This meeting served a dual purpose: namely, annual election of officers for the 1953–54 season plus the feature of a ladies night.

Gordon Storin, chairman, called the meeting to order and announced the program. Mr. Storin called on Joseph Reichert for his remarks of welcome to the ladies. He called them our main support and tower of strength that inspire and encourage us when our life problems are rough.

Mr. Storin next called for the election of officers. A slate of officers was presented by Irving Earle, chairman of Nominating Committee. The chairman read the list of nominations and called for other nominations from the floor. No other nominees' names were presented so in a voice vote following, the complete slate of officers were elected for the 1953–54 season:

Chairman—Gordon K. Storin, Niagara Alkali Co.
Vice-Chairman—James J. Forsythe, International Paper Co.
Secretary—Fred P. Heil, Lockport Felt Co.
Treasurer—E. F. Andrews, International Paper Co.
Program Chairman—Paul U. Bretschger, Buffalo Electrochemical Co.
Vice-Chairman—Caleb Taft, International Paper Co.
Publicity Chairman—Donald M. Hart, Moore Business Forms, Inc.
Vice-Chairman—Francis R. Webster, Moore Business Forms, Inc.
Vice-Chairman—M. S. Thomson, Moore Business Forms, Inc.
Arrangement Committee
Chairman—George Norton, George Irish Paper Co.
Vice-Chairman—Claire Walworth, Carborundum Co.
Attendance Committee
Chairman—Irving Earle, Upson Co.
Vice-Chairman—Ward Arnold, International Paper Co.
Membership Committee
Chairman—Fred Shelden, Buffalo Electrochemical Co.
Committee Members—Bob Zinsmeister, Kimberly Clark Co., Edgar Miller, Carborundum Co., and Leroy Lindberg, Robert Gair Co.

After the election of officers had taken place, Mr. Storin introduced each person in attendance. He next introduced Mr. Johnson, Superintendent of Horseheads Plant of National Homes Co., who in turn presented a colored sound film titled, "Homes Unlimited." Movies traced the history and progress in development of prefabricated homes. From the response and show of enthusiasm, the ladies were especially pleased.

This concluded the formal part of the meeting and was followed by dancing and cards.

Francis Webster, *Recorder*

Ohio

One hundred thirty-nine members of the Ohio Section participated in an afternoon and evening of fellowship and education in Springfield, Ohio, on April 9, 1953. The afternoon schedule consisted of a trip through Bauer Brothers Co. plant where they observed the manufacturing operations in connection with the building of pulp refineries, double and

At the Ladies' Night program of the Northern District of the Empire State Section: R. A. Premo, W. G. Garlough, Mrs. Garlough, J. H. Treadwell, Mrs. Premo, Mrs. Murtaugh, H. A. Spencer, Mrs. Parmele, J. D. Parmele, R. J. Murtaugh, Mrs. Treadwell, S. J. Young and Mrs. Young

single revolving disk attrition mills, bark removers, and centri-cleaners.

Disk refiners are now creating new interest in refining procedures especially in the case of fringe operations where lower cost production and better wood utilization are important considerations. The bark removal system is at the point of commercial installation and field trial and several installations will be in service in the coming year. There are many installations of centri-cleaners at the present time and many more are contemplated.

One of the most interesting features of the plant at Bauer Brothers is the Fiber Products Laboratory. This organization is maintained to serve manufacturers of groundwood, chemical pulps, semichemical pulp, paper, fiberboard, wallboard, hard board, and kindred products. It is equipped with commercial sized equipment and designed to bridge the gap between miniature experimentation and commercial scale operation. The laboratory is sponsored by the Bauer Brothers Co., the Briggs Boiler Works Co., Coe Manufacturing Co., Downingtown Manufacturing Co., Oliver-United Filters Inc., and United States Wall Board Machinery Co., Inc. and is available for private researches at nominal rental. The personnel is made up of a well-balanced staff of trained technicians under the supervision of men of long practical experience in the fiber processing field and hundreds of tests are made annually, involving the use of scores of materials from all over the world. The findings are set forth in detailed confidential reports which are often of inestimable value to the clients.

Following the Bauer Brothers inspection, the group adjourned to the Crowell-Collier Co. cafeteria for dinner and an inspection trip through the printing, binding, and rotogravure divisions of the plant. Allen C. Black, Superintendent of the Gravure Preparatory Dept., gave an excellent talk on the development of the gravure printing processes at this plant as follows:

"The Crowell-Collier Publishing Co. publishes three nationally circulated magazines: *Collier's*, a weekly, with an average net paid circulation of 3,106,000; *Woman's Home Companion*, a monthly, with an average net paid circulation of 4,300,000, and the *American Magazine*, a monthly, with an average net paid circulation of 2,579,000. This is a combined monthly total of approximately 19,000,000. Based on four 5-day weeks per month, we produce about 1,000,000 magazines per day.

"In addition to our own publications, we print a complete 28-page magazine each month for *Friends* and a 20-page signature for *Family Circle Magazine*.

"The gravure process is not a new one at Crowell-Collier. We started printing gravure on a small scale in 1916 in monotone only and on one press. At that time we employed approximately 20 persons. The first four color pages printed in gravure appeared in the February, 1936, *Woman's Home Companion* and later in the *American Magazine* and *Collier's*.

"In 1952 approximately 80% of all pages printed at Crowell-Collier were printed in gravure.

"Today we employ approximately 300 people in the Gravure Preparatory Dept. and 350 in the Gravure Press Room or a total of approximately 650 directly producing gravure.

"Gravure printing has increased tremendously in recent years. In addition to magazines and newspapers, a large amount of the package printing is in gravure. As examples, cigarette packages, soap wrappers and boxes, candy bar wrappers, and wrappers for chewing gum. Gravure is well suited to packaging because of the speed and the long runs which are possible from one set of chromed cylinders.

"Improvements in the process are constantly being made in the preparation of the printing cylinders and in press equipment. Our presses are equipped with electric eyes to control register. The pressure of the doctor blade and impression rollers is controlled automatically. All these things result in a better printed result.

"The ink manufacturers are continually seeking ways and means to improve their product. That is also true of paper and other suppliers of material used in the gravure process. As an example, we are now printing our *Collier* covers on 70-lb. coated paper. Printing gravure on coated stock has always been a problem because of a grainy effect which apparently is due to uneven coating. New inks have been developed for printing on coated stock and we feel we have been fairly successful in reducing the grainy effect.

"In addition to the improvements being made in equipment and materials, considerable thought is being given to better training of the people employed in producing gravure cylinders. Practically all printers of gravure are members of the Gravure Technical Association. This association has only been in existence for the past 5 or 6 years. Its purpose is solely for the betterment of the gravure industry as a whole and it is a nonprofit organization. Each year, various members are assigned to committees to work on some problem. The committees meet at various times throughout the year to report progress made. Then at the annual meeting a complete report is presented to the entire association. Any expenses involved in attempting to find the answer to various problems are paid by the participating firms. At our last annual meeting there were approximately 350 people in attendance. This will give you some idea of the growth of the association during the past few years.

"At the present time, the Crowell-Collier Publishing Co. and two other gravure plants are installing equipment for a radical change in the procedure of producing gravure printing cylinders. This change has to do with the elimination of carbon tissue.

"Carbon tissue is the medium of transfer from the positive to the copper printing cylinder. Carbon tissue is a pigmented gelatin, made sensitive to light by sensitizing in a bichromate solution. After sensitizing, the carbon tissue reacts very quickly to temperature changes and also changes in character depending upon the time which elapses between sensitizing and printing to the positive.

"This substitute material is a silver sensitized gelatin much like photographic emulsions. After development and fixing the material can be kept for several months before being laid and etched on the copper cylinder with little or no change in character. As a result we believe our etchings will be more uniform.

"In my opinion, the next 5 years will bring forth many other improvements in the gravure process as well as in the other printing processes. The field of electronics is being applied to printing in the form of electronic scanning of copy to produce color-separated negatives. It is also being applied through instruments to measure densities for better control throughout the process."

The meeting was honored by the presence of the National President of TAPPI, George H. Pringle, Vice-President of the Mead Corp., Chillicothe, Ohio. We feel doubly honored when he attends our meetings because he is also a member of the Ohio Section.

GEORGE B. GREGG, *Recording Secretary*

Ladies' Night, May 23, 1953; Eastern District of the Empire State Section: G. C. Cole, Mrs. Cole, H. H. Lavery, Mrs. Lavery, J. W. Crocker and Mrs. Crocker

Zero-Span Breaking Length of Pulp*

TAPPI Suggested Method T 231 sm-53

THIS SUGGESTED METHOD IS UNDER THE JURISDICTION OF THE PULP TESTING COMMITTEE

THE objective of this method is to provide a means (1) for determining an index of the average ultimate strength of the randomly oriented fibers in a pulp test handsheet, and (2) for determining an index of the degree of bonding between fibers in the sheet by obtaining the ratio between the normal and the zero-span breaking lengths of test sheets made in accordance with TAPPI Standard T 205 m.

The means for accomplishing this test is a specially constructed pair of supplementary jaws which are inserted in the jaws of a conventional tensile testing machine. They are so designed that they clamp adjacent areas of the test strip. There is zero jaw separation at the start of the test. Special care must be taken to secure correct alignment of the jaws during clamping and throughout the test.

APPARATUS

1. A tensile tester in accordance with TAPPI Standard T 404 m having a range of at least 20 kg. (or 45 pounds).

2. A Clark zero-span jaw attachment as shown in Fig. 1. This shall comprise two pairs of jaws, AB and CD, made from hard-tempered tool steel. One pair of jaws, CD, is fixed to plate E and the other pair, AB, slides in this plate and may be clamped to it by means of the knurled screw, F. Tangs are provided at the ends of the pairs of jaws to permit the attachment to be clamped in the stressing jaws of the tensile tester. The outer jaws B and D shall be movable and arranged so that they can be closed against the inner jaws A and C by means of the screws G and H and springs J and K with a fixed pressure which, however, is variable by adjusting the thicknesses of the washers L and M. When the screws G and H are loosened, jaws AB and CD are caused to open by springs situated in jaws at N and O, to a distance controlled by the screws P and Q. Jaws B and D pivot on spherical or conical seatings R and S. The angle of contact between the pairs of jaws AB and CD is increased by screwing in the screws T and T′ and is normally set about 1°, so as to increase the applied pressure at the tips of the jaws.

Figure 2 shows an enlarged view of the tips of the jaws AB and CD. VU is the tip of the jaw A, WU is the tip of jaw B, and YU and XU are the tips of jaws C and D. ZZ′ is the plane of the clamping surfaces. The jaws are preferably cut with an angle of about 40° between faces VU and YU and between WU and XU. When tightened in position, the gripping edges U of the four jaws A, B, C, and D shall lie in the plane ZZ′ to within 0.0001 inch (2.5 microns). The gripping faces of the four jaws shall be provided with three or four grooves as shown, but the distance from the edge of each groove nearest the common contact line U shall not be less than 0.04 inch (1 mm.).

The width of the jaws AB and CD shall be 15 ± 0.05 mm. (0.592 ± 0.002 inch) and their outer surface (sides) shall be in alignment to within the same tolerance.

The thickness of the tangs at the ends of the jaws shall not exceed 0.05 inch (1.2 mm.) and the distance between them shall be such that they fit into the jaws of the tensile tester when its jaws are about 180 mm. apart.

Note: Because of the close tolerances necessary, any rusting of the tips of the jaws may impair the accuracy of the test. When not in use the attachment should be oiled with a light, noncorrosive machine oil and kept in a desiccator or a quart Mason jar containing a quantity of anhydrous silica gel.

CALIBRATION

Loosen screw F a quarter turn and slide jaws AB in plate E. Check that friction is absent and also that there is no lateral looseness of the jaws in the slide.

Press the tips of the jaws AB and CD together and tighten the clamping screw F. Tighten screws G and H and place the assembly under a microscope with a magnification of 50× or greater. Check that the edges of the four jaws A, B, C and D meet at a line U (Fig. 2) within the given tolerances on both sides of the assembly. Loosen screws G and H and adjust screws P and Q so that the tips of jaws AB and CD open apart from 1 to 1.5 mm. (about $^1/_{16}$ inch). Insert a strip of thin paper between the jaws AB and CD and tighten screws G and H until they just meet their stops. Loosen these screws, remove the strip of paper and, with a hand lens, examine the imprint of the jaws. See that there is no discernible ridge in the paper corresponding to the line U in Fig. 2 and that the compression-strip marks under the tips of the jaws are uniform in appearance.

When screws G and H are tightened to their stops, they should exert equal pressures. Measure the distance to which each is compressed and, by means of a

* This method is suggested by the Standards Committee as being the most suitable to date. It is *not*, however, a TAPPI Standard. Criticisms are earnestly requested and should be sent to R. G. Macdonald, Secretary, Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York 17, N. Y.

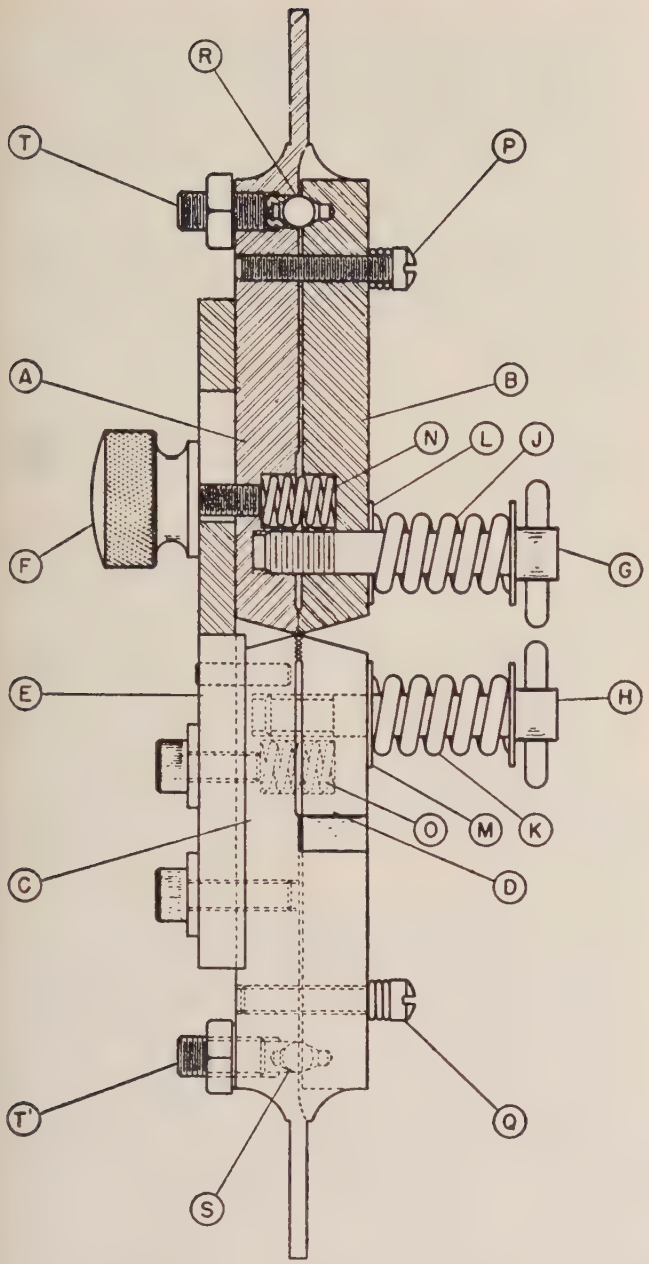


Fig. 1. Zero-span jaw attachment

compression tester or a suitable lever or a dead weight, check that when they are in their compressed state, approximately equal pressures are exerted. If not, adjust the thickness of the washer L or M until this is secured.

Clamp the attachment in the tensile tester and, carefully following the test procedure as later described, obtain an average reading on five strips of a good quality of kraft wrapping paper.

Retest the same sample with an extra $^1/_4$-inch washer added to L and M so as to increase the effective clamping pressures, and note if the average test is now significantly higher or lower. If higher, add a second washer to each and again carry out the test, and repeat until the test results show a decrease, or at least no increase. If all the compression of the springs is taken up with the added washers and the test results continue to increase, the springs should be replaced with stronger ones. Normally a spring with five turns of 0.10-inch diameter steel wire will be found suitable. If the added washers cause a decrease in the test results, this is an indication that the optimum clamping pressure has been exceeded and the added washers should be removed.

Note: The effective clamping pressure may be increased for special purposes by increasing the clamping angle between the pairs of jaws by adjusting the height of the pivot points R and S by means of screws T and T'. However, this may disturb the coincidence of the tips of the jaws. In general, it has been found that the optimum closing pressure required is not very critical, provided that the tips of the jaws are coincidental.

Disconnect the upper jaws AB and clamping screw F from the attachment and weigh and record the combined weight to the nearest 0.05 kg. (0.1 pound).

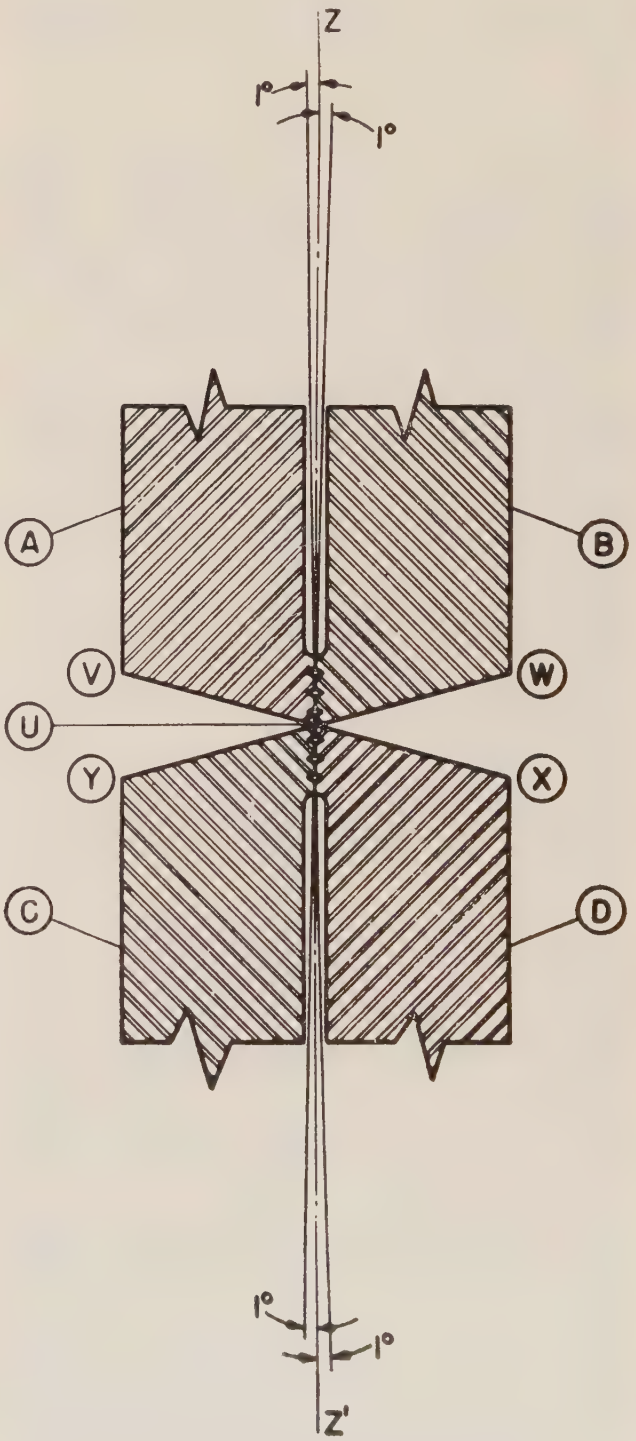


Fig. 2. Jaw tips

TEST SPECIMEN

The specimens for test shall consist of strips cut from pulp test sheets, preferably made in accordance with TAPPI Standard T 205 m, between 6 mm. (1/4 inch) and 18 mm. (3/4 inch) wide and of any convenient length over 15 mm. (5/8 inch). It is convenient to cut the strips parallel and adjacent to the strips cut for the conventional tensile test from the same handsheets.

Note: The exact dimension of the fracture in the specimens is controlled by the width of the jaws (15 mm.) so that, provided the area of each specimen is such as to enable it to be securely clamped across the entire line of fracture, the actual size of the specimen is immaterial because the portion, if any, protruding from the sides of the jaws will not affect the results.

The test specimens shall be conditioned and the tests made in an atmosphere conditioned in accordance with TAPPI Standard T 402 m.

PROCEDURE

Loosen the clamping screws G and H until the jaws are fully open (about 1 to 1.5 mm.). Loosen the knurled screw F slightly, press the tips of the jaws firmly together and, while still under pressure, tighten the screw. This is conveniently done by pressing one of the tangs of the attachment against the top of a bench or the body with one hand on the other tang and tightening the screw F with the fingers of the other hand.

Insert one end of the test strip between the opened jaws so that it projects beyond the other side and adjust its position so that the strip is located beneath the serrated clamp surfaces. Tighten one of the screws G or H finger-tight to hold the strip in position. With the key provided, tighten the other screw all the way in until it just meets its stop; then with the key, similarly tighten the other screw.

Lock the pendulum of the tensile tester at zero and set its jaws about 180 mm. apart. Place the attachment with the specimen centrally in the jaws of the tensile tester and clamp firmly in position.

Note: Should the jaws of the tensile tester be for a specimen width other than 15 mm., it is desirable if they are wider to attach a stop on the jaws to center the tangs automatically, or if they are narrower, it will be necessary to reduce the width of the tangs to suit. In any case, the attachment must be clamped so that its center line coincides with the center line of the jaws of the tensile tester.

Unlock the upper jaw of the tensile tester, unlock its pendulum, and apply a load at a rate in accordance with TAPPI Standard T 404 m and immediately loosen clamping screw F a quarter turn, meanwhile keeping one hand on the stop lever of the tensile tester. When the specimen breaks, *immediately* stop the stressing jaw of the tensile tester; otherwise, with the construction of the attachment, if the stressing jaw moves 1/4 inch further, the pendulum will be further loaded and the indicated reading lost.

Caution: Be careful not to put the stop lever into reverse at this point, otherwise the attachment may jam between the closing jaws of the tensile tester and cause serious damage to the latter.

Record the indicated breaking load to the nearest 0.1 kg. (0.2 pound) and remove the attachment from the tensile tester. Now reverse the stressing jaw of the tensile tester to return it to its starting position. Loosen the clamping screws G and H of the attachment and remove the broken specimen, or pull the specimen strip along to a new place beyond the fracture. Press and clamp the zero-span jaws together and proceed as before to make the next test. Make at least five individual tests on each strip. Discard any individual results which are 10% or more below or above the average of the others, as such results are probably caused by a hidden defect of the sheet.

Subtract the weight of the upper zero-span jaws and knurled screw F from the average of the test results, to give the zero-span breaking load. Determine the moisture-free basis weight of the specimen in grams per square meter.

REPORT

Report the zero-span breaking length in meters, calculated from the average zero-span tensile strength of the specimen, as follows:

$$\text{Zero-span breaking length} = \frac{200{,}000p}{3r} \text{ or } \frac{30{,}240P}{r}$$

where

p = zero-span tensile breaking load in kg. on the 15-mm. width
P = zero-span tensile breaking load in pounds on the 15-mm. width
r = average moisture-free basis weight of the specimen in grams per square meter

If desired, calculate the ratio between the zero-span breaking length and the normal breaking length for the same sample and report as Breaking Length Bonding Index.

ADDITIONAL INFORMATION

1. The zero-span test has good reproducibility, probably within 5%, if care is taken with an accurate finish and calibration of the attachment, and the sheets tested have a thickness greater than 0.002 inch. The highest skill and care are required in making them, so that, unless exceptional facilities and workmanship are available, attempts to produce a "homemade" attachment will probably result in disappointment.

2. The zero-span breaking length of a pulp will not significantly increase with beating after the first beating period has served to compact the test sheets. If the results either increase or decrease substantially with beating, it is an indication that the zero-span attachment is defective.

3. The zero-span breaking length of a pulp is independent of the type of beating equipment employed to consolidate the sheet. Usually about 20 minutes in the laboratory beater or pebble mill (TAPPI Standards T 200 m and T 224 sm), or 5 revolutions per gram in the kollergang (TAPPI Standard T 225 sm) are sufficient to compact the sheets.

4. The zero-span breaking length may be regarded as the maximum possible normal tensile breaking strength realizable with ideal beating equipment. In most instances, therefore, its employment obviates the necessity for determining the maximum burst factor of a pulp specimen.

REFERENCES

Clark, James d'A., "The Measurement and Influence of Bonding Between Paper Fibers," *Paper Trade J.* 116, No. 5: 29–35 (Feb. 4, 1943); *Tech. Assoc. Papers* 26: 462–468 (1943).

Clark, James d'A., "The Ultimate Strength of Pulp Fibers and the Zero-Span Tensile Test," *Paper Trade J.* 118, No. 1: 29–34 (Jan. 6, 1944); *Tech. Assoc. Papers* 26: 285–290 (1943).

RECENT BOOKS

Encyclopedia of Chemical Technology. Vol. 10. Edited by Raymond E. Kirk and Donald F. Othmer, Polytechnic Institute of Brooklyn. The Interscience Encyclopedia, Inc., New York, 1953. Cloth, $7^1/_2 \times 10^1/_2$, 976 pages. Illustrated. $30.

The first nine volumes of this series have been reviewed in *Tappi*. The above-mentioned price of $30 applies to this volume only. Individuals or companies who are subscribing to the entire series of 15 volumes will be charged $25 for this volume.

Volume 10 covers subjects alphabetically from Pentacene to Polymethine Dyes. Included are such subjects as perfumes, peroxides, petroleum, waxes, pharmaceuticals, phase rule, phenols, plastics, phosphorus, photoelectric cells, photography, pigments, pilot plants, pipes and valves, plant layout, plasticizers, plywood, and polymers.

The series is a "must" for any comprehensive library on technical subjects.

Industrial Wastes. Edited by Willem Rudolfs, Chairman, Department of Sanitation, New Jersey Agricultural Experiment Station, Rutgers University. Reinhold Publishing Corp., New York, 1953. Cloth, 6 × 9, 500 pages. $9.50.

"Industrial Wastes" has been designated as A.C.S. Monograph No. 118. Seventeen collaborators assisted Mr. Rudolfs in the preparation of this excellent book.

The volume consists of a survey of waste problems in several industries. The chapter on pulp, paper, and paperboard was written by Harry W. Gehm, a member of TAPPI and an employee of the National Council for Steam Improvement.

Mr. Gehm's chapter considers pulp mill wastes, sewage treatment methods, deinking wastes, strawboard waste, and bleaching wastes. Another chapter covers stream pollution and self purification.

Chemical Process Machinery. 2nd Ed. By E. Raymond Riegel. New York, 1953. Cloth, 6 × 9, 735 pages. Illustrated. $12.50.

Many readers of *Tappi* are familar with the first edition of "Chemical Processing Machinery." The new, enlarged edition brings the material of the previous edition up to date. Only equipment that is commercially available is considered by the author.

Among the subjects covered are screening, materials handling, tanks, weighing, evaporation, driers, heat exchangers, and instrumentation. The book is of particular value to engineers, chemists, and process industry executives who have to select plant equipment.

Mechanical Properties of Wood and Paper. Edited by R. Meredith, University of Manchester. Interscience Publishers, Inc., New York, 1953. Cloth, 6 × 9, 300 pages. Illustrated. $7.25.

In the preparation of this excellent book Mr. Meredith is assisted by W. W. Barkas, reader in papermaking technology of the University of Manchester, R. F. S. Hearmon of the British Forest Research Laboratory, and H. F. Rance, director of research of the Wiggins Teape Group Research Organization. The book was originally published by the North Holland Publishing Co. and distributed by Interscience Publishers, Inc. It is one of a series of monographs on Deformation and Flow—The Rheological Behavior of Natural and Synthetic Products.

The first part of the book is devoted to the properties of wood. Included in the part on paper are such subjects as: the papermaking process from a rheological standpoint (beating, sizing, formation, and drying), arbitrary testing of paper (tensile, burst, tear, fold, rigidity, softness, and brittleness), hygrosensitivity, tensile studies, structure, compressibility, and instrumentation.

The volume should be included in the library of every research department in the paper industry.

Dictionary and Encyclopaedia of Paper and Paper-Making. 2nd Ed. By E. J. La Barre. Swets & Zeitlinger, Amsterdam, 1952. Cloth, 6 × $8^1/_2$, 500 pages. $10.20. (Copies may be obtained also from The Oxford University Press, London and Toronto.)

Mr. La Barre's book was reviewed briefly in the May, 1953, issue of *Tappi*. The following review is an American view of the book by William Bond Wheelwright.

E. J. La Barre's new and more inclusive edition of his previous scholarly work, "A Dictionary of Paper and Paper-Making Terms," comes as an important addition to the bibliography of paper. It should be as welcome in the United States and Canada as in Great Britain. The American could find himself as confused by English paper terminology as was the "English traveler" with shop signs in America. We, for example, have no such term as "mill glazed," and ironically, "English finish," is not a British term. This and other characteristically American paper terms were absent from La Barre's first "Dictionary of Paper," whereas a large number are included in the new book. This enhances its value to Americans, but without diminishing their reliance on the "Dictionary of Paper" (2nd ed., New York, 1951), published under the auspices of the American Paper and Pulp Association; it contains approximately 4000 definitions, including pulps, boards, paper properties, and related papermaking terms, as well as some of the British. But it is strictly technical.

Any American whose interests in the paper industry go beyond the technical or business requirements, will surely wish to own a copy of La Barre's new work, which is much more than a dictionary, as its title implies. It will be of wide interest to bibliographers and librarians and others, including those concerned with the graphic arts. No one is likely to complain that the author has taken us too far afield, for paper has innumerable ramifications into various human activities, arts, and crafts, making it difficult to establish strict definitive limitations. As the author points out in his Introduction, "All this debatable vocabulary has had to be dealt with and if the definitions of the words and their meanings, collected from books and journals or extracted from long-suffering experts, have become too lengthy, the fault lies rather, I think, with my material than with myself, though of course my zeal may well have outrun my discretion."

In addition to his business experience as a stationery expert Mr. La Barre had unusual qualifications for his chosen task. An accomplished linguist, he became a Sworn Translator in 1905, and served as British Vice Consul at Amsterdam for many years under W. A. Churchill, Esquire, author of "Watermarks in Paper in the 17th and 18th Centuries" (1935). From him he acquired his abiding devotion to the study of paper and papermaking. The thoroughness of his learning in this field, the meticulous pains with which he has worked, are evident to a conspicuous degree in the "Dictionary and Encyclopaedia of

Paper and Paper-Making." Possibly only one who has also delved in this field and compiled a glossary himself, can begin to visualize the magnitude of the works accomplished by La Barre.

An outstanding feature of the technical dictionary comprising the larger part of this latest book is the listing of equivalents in French, German, Dutch, Italian, Spanish, and Swedish, which occupy the last 104 pages of the 488-page volume. Each word indexed bears a number referring to the page and entry in the Dictionary. Thus a translation from any of the six different tongues may be readily found.

References to authorities for definitions are similarly documented and these number 259! Bibliographies are conveniently arranged under appropriate headings, comprising a total list of 259 titles. Thus a search for any particular phase of the subject of paper will be helpfully expedited.

Worthy of special mention are two signatures—one about wallpaper of 16 pages, evenly divided between text and illustrations, by E. A. Entwisle, Director of Wall Paper Manufacturers, Ltd. of Manchester and London; the other, a monograph on Watermarks, of 32 pages by the late Edward Heawood. Its 16 pages of illustrations show reproductions in line of 232 watermarks, dating from A.D. 1313 to 1784. These include European, British and American examples.

A section devoted to printing papers and another to wrapping papers and a third about writing papers will be appreciated especially by the layman interested in such information. The confusing nomenclature of English paper sizes and of certain other countries arranged in tabular form includes, Writing, Printing, Drawing, Wrapping, Boards, and Miscellaneous. It is followed by a "Table of Dimensions of Paper Sizes and Their Names" and covers 21 pages. This unexampled compilation should be of particular value to antiquarians in search of bibliographical evidence.

The main facts relating to contemporary sizes and names may be found under the heading, "Standardization," but without reference to American paperboards or wrapping papers.

As an example of contemporary book production, the "Dictionary and Encyclopaedia of Paper and Paper-Making" is praiseworthy. The paper, typography, and presswork are all very good. The flexibility of the binding, due to having the grain of the paper running parallel to the shelf-back, makes the book easy to handle and allows it to remain open at any selected page. This property in a book of reference is an asset. Those book manufacturers who doggedly adhere to having the paper grain otherwise, cause the reader annoyance without compensating advantages. The Oxford University Press is to be congratulated upon having published Mr. La Barre's important volume in such admirable form.

Note: The books reviewed in this section may be obtained through the Recent Books Department of the Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York 17, N. Y.

EMPLOYMENT SERVICE

Positions Open

P309-53. Plant Superintendent wanted by West Coast paper converting plant. Must be experienced in rotary printing, single-face corrugating, laminating, some knowledge of chemistry, and thorough knowledge of paper. Challenge to a man wanting advancement. Reply stating age, references, experience, and salary expected.

P313-53. Chemist to take charge of Paperboard Research Laboratory. Work will be closely related to pulping, paperboard mill, converting, and sales operations. Applicant should be well grounded in technical fundamentals and paperboard manufacture. Upper Midwest location.

P314-53. Excellent future for a college graduate possessing a paper background in production, sales, or market research who desires a challenging position in marketing research with a large progressive paper manufacturer. Our employees know of this opening. Reply giving personal, educational, and work history plus salary expected.

P315-53. Graduate chemical engineer, preferably with pulping experience, wanted as manufacturer's representative to sell in Pennsylvania, New York, and New England.

P316-53. Paper and/or Packaging Chemist with some experience in some or all of the following: adhesives, printing inks, quality control, product development research. Age: late twenties, early thirties. Rapid advancement with excellent opportunity for right man. Starting salary: $70–90 per week.

P317-53. Chemist or Chemical Engineer desired for the quality control department of an eastern plant manufacturing paper containers for moist or liquid foods.

Positions Wanted

E238-53. Chemical Engineer. Seven years' directing gumming and resin coating development for leading paper converter. Considerable technical service and market development work on this job. Nine previous years in organic synthesis—research, design, and production. Desires position with increased responsibility.

E239-53. Paper Executive, possessing firmly organized background of production management, sales, and costs in the paper industry seeks position with a mill or mills as a representative or in a management position. Experience includes management of kraft specialty mills, direction of area sales, development of new products; also production and sales of tissue products, decorated and fancy papers. Has high record of cost and financial ability. Prefers New England but will relocate.

E240-53. Paper Technologist—15 yr. practical and technical experience in fine paper as chemist superintendent and in technical advisory work. Background covers wide variety of papers processes and equipment. Desires production or technical position where ability will be fully utilized.

E241-53. Dissolving Pulp Specialist. Ph.D. 15 yr. experience in pulp and paper especially viscose and other dissolving grades. Seven years effective research direction, including pilot plant. Development and mill application of quality improvement and control methods in both kraft and sulphite. Successful in improving customer relations.

RESEARCH CHEMIST

Excellent opportunity in research and development department of coated paper manufacturer. Innate ability of primary importance. Experience in lacquer and/or paper chemistry helpful. Send résumé of education, experience, personal data, and salary requirements to Research Director. Plastic Coating Corporation, Holyoke, Mass. (P310-53).

SALESMAN

WET STRENGTH RESINS

Experience in paper making essential, good opportunity for high commission earnings for aggressive salesman. Submit complete résumé and salary requirements. Reply to Box P311-53, Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York 17, N. Y.

PAPER CHEMIST

Experienced paper chemist for technical service laboratory. Applied research and technical service in use of starches in paper making. Interesting work, good working conditions, some traveling. Please send complete details with first letter to A. E. Staley Mfg. Co., Decatur, Ill. (P312-53).

Note: Responses to the above inquiries should be sent to the Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York 17, N. Y.

Chemicals from Douglas-Fir Bark

E. F. KURTH

In the Fall of 1947 the Oregon Forest Products Laboratory began investigating the chemical composition and utilization of western tree barks. One of the first barks investigated was that of Douglas-fir. Other barks that have been examined or are now under study are ponderosa pine, sugar pine, lodgepole pine, Jeffrey pine, Port Orford cedar, incense cedar, western red cedar, white fir, and grand fir.

Some of this work has been carried on jointly with the Department of Chemistry, Oregon State College.

DOUGLAS-FIR BARK CHEMICALS

Based on an annual cut of 6 billion board feet of Douglas-fir lumber in the states of Oregon and Washington and calculated on the basis that 20.8 cu. ft. of bark having a specific gravity of 0.40 are available from each thousand board feet of logs, the potential annual supply of such bark is about $1^1/_2$ million tons. (The production of Douglas-fir lumber in the year 1950 was over 10 billion board feet.) The bark can be separated mechanically into cork, needlelike bast fibers, and a fine amorphous powder.

The cork is interspersed in the reddish-brown bark as light-colored layers varying in thickness from $^1/_{32}$ to $^3/_4$ in. This Laboratory has found that Douglas-fir sawlog bark contains, by weight, from 25 to more than 50% cork, 30 to 42% of the short needlelike bast fibers, and 20 to 35% of the amorphous powder. The cork particles contain approximately 40%, the bast fibers 20%, and the amorphous powder 34% of extractives. Sound whole bark contains from 25 to 30% of extractives.

Destructive distillation of the bark in an oven-type retort produces yields of approximately 45% charcoal, 10% tar, and 18% combustible gas. This yield of charcoal is higher than that for wood, whereas the yield of tar and combustible gas is of the same order as that obtained from wood.

Most of our work thus far on bark components has been on the extractives. Three substances are present in Douglas-fir bark in commercially extractable quantities and have important potential industrial uses. These are tannin, wax, and the flavanone, dihydroquercetin.

Tannin

The tannin content of sound Douglas-fir bark, when determined by the procedure of the American Leather Chemists Assn., varied from 7.5 to 18%, based on oven-dry bark weight. The largest amount of tannin was found in the bark of young second-growth trees 57 to 70 yr. of age and the tops of older trees. The least amount of tannin was found in the bark of butt logs of old-growth trees. Bark, hand-peeled at a peeling plant, from poles and piling 32 to 43 yr. of age averaged 9.0% tannin content.

In the conventional pole-peeling operation, the bark refuse contains about 50% wood. Hence, this bark and wood mixture would average less than 5% in tannin content which is considered too low for commercial extraction. In addition, the sapwood removed with the bark contains nontannin water-soluble substances, which lower the purity of the tannin extract.

Several bark samples, hand-peeled from logs in the woods soon after the trees were felled and then dried, were analyzed for tannin content during the past two years. This bark, up to 2 in. in thickness, has averaged quite consistently about $12^1/_4$% tannin. In the commercial extraction of properly cured bark, a yield of 10% based on the oven-dry weight of the bark, may be expected. This tannin yield is about the same as that of eastern hemlock bark. Hence, from 1 ton of bark, 200 lb. of tannin may be expected in commercial extraction. This amount of tannin at 18 cents per lb. amounts to $36 per ton of bark. Assuming a tannin recovery of 10% $1^1/_2$ million tons of bark would produce about 273,000 tons of powdered extract containing 55 to 60%, or about 150,000 tons of actual (100%) tannin.

Cost estimates for producing a pound of 100% eastern hemlock tannin were obtained from industrial firms during the past year. Exclusive of raw bark costs and based on a 10-yr. plant amortization period, the estimated costs of leaching the bark (about 1.5 cents) and evaporating the liquid extract to a dry powder (about 3.5 cents) total between 5 and 6 cents per lb. of actual tannin. Including the cost of eastern hemlock bark at $17 per ton (8.5 cents per lb. of actual tannin), the total estimated cost of producing 1 lb. of actual hemlock tannin is between 13.5 and 14.5 cents. Douglas-fir bark at $2.00 per ton would give a raw material cost of 1 cent per lb. of actual tannin. Excluding bark drying costs, the cost of producing 1 lb. of actual Douglas-fir tannin would be between 6 and 7 cents.

The tannin in Douglas-fir bark is easily extracted with hot water. In the conventional countercurrent process, leach water temperatures up to 200°F. may be used without converting the tannin to insoluble phlobaphenes. The total extraction time, with five leaching tanks in series, may be 15 hr., with 80 to 90% recovery of available tannin. Several factors, particularly bark particle size and method of grinding, affect the rapidity and completeness of tannin extraction.

A light-colored tannin is produced when the aqueous extract is concentrated to about 50% solid matter in a vacuum drier and subsequently dried to a powder form in a spray or a vacuum drum drier. The powdery extract from well-cured bark will contain from 55 to 60% actual tannin and 40 to 45% nontannins.

The annual consumption of vegetable tannin in this country is estimated to be about 150,000 tons of actual tannin of which about 70% is imported. Quebracho tannin from Argentina is imported in the greatest amount. The chief source of domestic vegetable tannin is chestnut wood in the Appalachian area. A blight has killed most of the chestnut forest, and estimates indicate that this source of tannin may be exhausted before 1960.

Douglas-fir tannin compares favorably with quebracho tannin for all of the major industrial uses, and it has been used for many years in leather-making at the tannery at Dallas, Ore. Mr. Tu at the B. D. Eisendrath Memorial Laboratory, Racine, Wis., concluded from his tests on Douglas-fir bark tannin extract, made during the year 1950, "that Douglas-fir bark is comparable to quebracho tannin. The leather produced was full, firm, and had an agreeable light tan color. The tannin fixation, shrinkage temperature, and other characteristics of the leather all revealed that Douglas-fir bark tannin resembles quebracho tannin." He found that it could be blended with other tannin extracts. In his opinion, "from the technical point of view, Douglas-fir bark extract could be developed very well into a satisfactory domestic tannin extract."

About 40 to 50% of the tannin consumed in this country is used by the petroleum industry for controlling the consistency of oil-well drilling muds. During the past year, two industrial laboratories have reported that Douglas-fir bark tannin compares favorably with quebracho tannin for this use.

The Bureau of Mines' Laboratory at Tuscaloosa, Ala., is interested in finding a material that will be beneficial for the concentration of low-grade iron ores. Their tests on Douglas-fir bark tannin extract, made during the past year, indicate that it is as efficient as quebracho tannin for this purpose.

Hence, it appears that a market for Douglas-fir tannin is available and all that remains is to produce it economically

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on a commercial scale. In this connection, there is an important problem that requires consideration. Douglas-fir tannin, like all other bark tannins, is quickly destroyed by enzymes, molds, fungi, and insects when the bark is wet or left on logs in the woods under conditions favoring attack by biological agents. To obtain the maximum yield of tannin, the bark must be removed from the logs soon after the tree is cut, and then it must be properly cured. Experiments conducted over the past two years have shown that a relationship exists between drying or curing methods and tannin yield and quality; improperly cured bark contains less tannin than well-cured bark. There is also the possibility that dihydroquercetin is converted to tannin during curing and storage of the bark.

The lumber industry on the West Coast does not on the whole practice bark salvage or debarking before sawing the logs into lumber. Bark that has been stored in millponds or left on logs lying in the woods will be low in tannin content. In order to obtain good tannin bark it will be necessary to debark the logs soon after felling the trees, possibly by debarkers at the mills, and to dry the bark in driers before storage. The drying operation could be most economically done in a bark drier at the tannin extraction plant. An analysis for the tannin content of one lot of bark removed with a hydraulic barker from logs ranging from 16 to 24 in. in diameter gave a 12 1/4% yield of tannin by weight.

Some of the advantages of debarking sawmill logs are: (1) a saving in lumber scale of at least 5%, (2) the sawyer has a better opportunity to inspect the log before starting breakdown into lumber, (3) there is a ready market for the clean barked slabs at pulp or hardboard mills, (4) there is less maintenance on saws and conveyor systems, (5) logs barked on land do not contribute to stream pollution, (6) there is a reduction in accident and fire hazards in a bark-free plant, (7) the bark has value, and (8) the general opinion of those experienced with debarking operation is that "debarkers are the coming thing for sawmills."

Wax

The second group of Douglas-fir bark extractives of potential commercial value includes the waxes. Douglas-fir bark contains on the average about 5% of a light-colored wax soluble in hexane or petroleum-type hydrocarbon solvents. In addition, it contains about 2 1/2% of a brown-colored wax soluble in aromatic-type solvents or in chlorinated hydrocarbon solvents. The total wax content of the bark taken from Douglas-fir sawlogs in the Willamette Valley has averaged quite consistently about 7.5%. The cork fraction in the bark contains the most wax; sometimes this amounts to about 13% of the oven-dry weight of the cork. The wax can be solvent-extracted from wet or dry bark; drying of the bark prior to wax extraction is unnecessary. Wax extracted with benzene or trichlorethylene from wet bark is usually red-colored, for a little of the tannin may be removed along with the water from the wet bark.

In the Laboratory's experimental batch extractor, approximately 90% of the wax was extracted from Douglas-fir bark with benzene in 3 hr. with nearly complete recovery of the solvent by steaming the extracted bark residue.

The color of the crude benzene-extracted wax from dry bark is light brown to reddish-brown. Approximately two thirds of the benzene soluble wax is soluble in hexane.

The melting point of the Douglas-fir bark waxes is about the same as that for beeswax. They, however, are harder than beeswax but not as hard as carnauba wax. The chemical composition of the hexane-soluble wax was found to be about 60% lignoceric acid, 20% lignoceryl alcohol, and 20% ferulic acid. Small amounts of sterols are also present

The ferulic acid is a very reactive aromatic acid and, as far as is known, Douglas-fir wax is the only vegetable wax that contains an aromatic substance of this nature. This material gives the wax many interesting and unique properties. It affords the organic chemist many opportunities to modify the properties of the wax. Ferulic acid itself may be converted into vanillin, a familiar substance.

During the past year this laboratory has had requests from a large number of companies for 1 to 10-lb. samples of the wax. For most important industrial uses of the wax, it would be desirable to raise its melting point, increase its hardness, and increase its solvent-retention properties. A simple, cheap means for accomplishing this now has been found. The melting point can be raised to exceed that of carnauba wax; in fact, the melting point can be increased as much as 50°C. Improvement in hardness and increase in solvent retention are also obtained. These properties are desirable when the wax is to be used on floors and for polishes.

Douglas-fir wax gives a clear, high gloss to wood surfaces. The hardened wax is easily applied and requires very little rubbing to give a highly lustrous polish. Douglas-fir wax also has the unique property of being easily emulsified. This is desirable when the wax is used for liquid polishes. We believe that the necessary changes desired by potential wax users have been accomplished and that the wax will find many large-volume uses.

This country imports all of its carnauba wax requirements, a major proportion of its candelilla wax, and about 70% of its beeswax requirements. Carnauba and candelilla are high-cost waxes. Calculated on the basis that a 5% yield of hexane-soluble wax is obtainable from Douglas-fir bark and assuming that it will sell for the price of beeswax, the potential value of the wax from 1 ton of dry Douglas-fir bark is $50.

It has been reported that it costs from $6.00 to $7.00 to solvent extract a ton of oil meal in a continuous-type extractor. It would appear that the cost of extracting a ton of Douglas-fir bark should be somewhat comparable.

No estimates have been placed on the potential value of the hexane-insoluble wax. This wax has a more complex chemical composition than the hexane-soluble wax containing lignoceryl alcohol, hydroxy palmitic acid, lingoceric acid, glycerol, a reddish-brown phenolic acid, and unsaturated hydroxy acids. The hydroxy acids in this wax are esterified to the phenolic acid and also to each other in an etholide-type linkage. The wax has a marked similarity to the "suberin" in cork. It has desirable properties and potential commercial value. The yield of this wax from Douglas-fir bark amounts to approximately 2 1/2% or 50 lb. per ton of dry bark.

The properties of three modified hexane-soluble wax products as determined by the National Bureau of Standards are given in Table I. The Bureau mentioned that "these waxes have properties which may make them useful as replacements for waxes that are now on the market; however, such replacement would depend upon consumer acceptance."

Table I. Properties of Modified Hexane Soluble Waxes

Sample	*Penetration, (mm)*[a]	*Softening point °C*[a]	*Acid number*	*Saponification number*
1.	0.3	78	70	161
2.	0.7	86	77	129
3.	0.7	98	76	160

[a] 5 sec. — 100-g. weight at 25°C.
[b] Ring and ball method Federal Specification P-W-158.

Dihydroquercetin

The third chemical of commercial importance occurring in Douglas-fir bark is dihydroquercetin. This is a white crystalline compound that belongs to the group of organic compounds known as "flavonoids." Yields of more than 7% have been obtained from some bark, the largest concentrations being found in the cork fraction of the bark. Some

Douglas-fir cork has been found to contain more than 20% by weight of dihydroquercetin.

Some flavonoids possess the pharmacological properties characteristic of the so-called vitamin P, are beneficial in the treatment of frostbite and fragility of blood capillaries, and are excellent antioxidants for the prevention of rancidity in fats and oils. Tests also are under way to determine their effectiveness for the treatment of radiation burns. The flavonoids differ in their abilities to accomplish the desired results when used for these purposes.

The naturally occurring yellow coloring matter, quercetin, has a high degree of activity for several of these uses. Rutin, a glucoside of quercetin, now is commercially extracted from buckwheat for the pharmaceutical trade and sells for about $15 a lb. Both of these materials appear to be nontoxic.

During the past year we have prepared and sent many samples of dihydroquercetin to laboratories for evaluations of its potential usefulness. Our tests and those of industry have shown that dihydroquercetin is an excellent antioxidant for the prevention of rancidity of food products. It compares favorably with propyl gallate, which is now used for this purpose. Mr. DeEds in the U. S. Department of Agriculture Laboratory at Albany, Calif., has reported that dihydroquercetin and quercetin are beneficial for the treatment of frostbite injury. Other clinical tests are still in progress. At this time, it appears that large-scale important uses for dihydroquercetin will develop. The current prices for rutin, quercetin, and related flavonoids make the production of dihydroquercetin from Douglas-fir bark appear very attractive.

Quercetin

Dihydroquercetin differs chemically from quercetin only in that it has two more hydrogen atoms in the molecule than quercetin. Dihydroquercetin is converted into quercetin quite easily by treatment with bisulphite solutions. For example, approximately 90% conversion to chemically pure quercetin is obtained by simple refluxation of dihydroquercetin in 5 to 20% aqueous solutions of sodium, potassium, or ammonium bisulphite; over 50% conversion is effected with dilute solutions and over 85% conversion is effected with concentrated solutions within one hour. Quercetin is insoluble in hot bisulphite solutions whereas dihydroquercetin and tannins are relatively soluble. It is not necessary, therefore, to start with pure dihydroquercetin in order to obtain pure quercetin. The quercetin separates from the above hot bisulphite solutions as bright yellow crystals with a melting point of 316 to 318°C. On the other hand with calcium bisulphite liquor such as used in the commercial pulping of wood, dihydroquercetin forms a yellow, insoluble calcium complex of quercetin. This material separates as a fine, impervious crust, which adheres tenaciously to the sides of the container. The above reactions offer an explanation for the fact that difficulty is experienced in pulping Douglas-fir chips with calcium bisulphite liquor, but not with ammonium bisulphite liquor.

Recent analyses in this laboratory of Douglas-fir bark obtained from operators of sawmills are given in Table II. The logs from which these samples of bark were taken had not been stored in water. The data show that a yield of 146 to 200 lb. of tannin, 130 to 204 lb. of wax, and 80 to 152 lb. of dihydroquercetin may be expected from a ton of sound sawlog bark. In the conventional hide powder method for tannin analysis, at least a part of the dihydroquercetin appears as tannin. Therefore, an overlapping in the yields of these two water soluble constituents occurs.

Table II. Analyses of Douglas-Fir Bark from Sawlogs

Percentage based on oven dry weight of bark

Source	*Tannin*	*Wax*	*Dihydroquercetin*
Rockport, Calif.	8.8	6.5	6.0
Taos, N. M.	13.6	9.2	7.6
Fall Creek, Ore.	7.3	10.2	4.0
Mollala, Ore.	8.1	8.0	5.5
Corvallis, Ore.	10.0	7.4	6.0
British Columbia[a]	7.0	8.3	4.7

[a] Logs stored in fresh water 90 days and in salt water 20 days.

TANNIN EXTRACTING EQUIPMENT

The following paragraphs include a suggested list of equipment that would be required for a commercial tannin extraction process using Douglas-fir bark.

Bark Drier

Adequate bark drying equipment can be fabricated locally. The Combustion Engineering Corp., Chicago, Ill., manufactures a grinder-flash drying combination mill. A six-unit, single-conveyor drier producing 2 tons of dry bark per hr., manufactured by Proctor and Schwartz Co., Philadelphia, Pa., costs $22,000.

Bark Grinders

These could be of the hammer-mill type, but a mill giving a shaving action is preferable.

Bark Leaching Tanks

These are circular wooden tanks varying from 10 to 18 ft. in diameter and from 10 to 17 ft. in height. They are generally equipped with a rotating arm to discharge the spent bark through a 2-ft. square opening in the bottom of the tank. The bark is extracted with hot water, countercurrently, in a series of four or five tanks.

Evaporators

A 100-ton per day bark extraction plant, using about 7.0 lb. of water per lb. of dry bark for leaching, will require an evaporator that has the capacity to evaporate about 53,000 lb. of water per hr. This evaporator requires 17,000 lb. of steam per hr. and 700 gal. of recondenser cooling water per min. The cost of this size evaporator, including pumps and interconnections, is about $150,000.

Initial temperature of the tannin liquor on the first stage may be 200°F. or less. Temperature of the final stage should be approximately 125°F. These temperatures are within the safe limits for Douglas-fir tannin extract.

Spray Driers

Prices for installed driers are as follows:

1. For a 10-ft. drier with a production capacity up to 12 tons of dry extract per day, the cost is about $45,000.
2. For a 14-ft. drier with a production capacity between 12 and 26 tons of dry powder per day, the cost is $70,000.
3. For an 18-ft. drier with a production capacity of from 26 to 38 tons of dry powder per day, the cost is $95,000.

SUMMARY

Douglas-fir bark contains potentially useful organic chemicals in commercially extractable quantities for which good markets exist. It is believed, from work done during the past two years on integrated extraction processes, that all of these chemicals may be produced from sawlog bark, and the extracted bark residue can still be used further for fuel, as soil conditioners, indestructive distillation, or for the mechanical separation of cork, bast fibers, and other bark products.

AVAILABLE LITERATURE

The following reprints are available on request from the Oregon Forest Products Laboratory, Corvallis, Ore.

1. "Utilization of Douglas Fir Bark," by E. F. Kurth, Harry J.

Kiefer, and James K. Hubbard. *The Timberman* 49, No. 8: 130–131 (June, 1948).
2. "The Chemical Analysis of Western Woods. Part II. Douglas Fir Bark Analysis," by E. F. Kurth. *Tappi* 32, No. 4: 175–176 (April, 1949).
3. "Douglas Fir Bark Tannin," by J. K. Hubbard and E. F. Kurth. *J. Am. Leather Chem. Assn.* 44, No. 8: 604–614 (Aug. 1949).
4. "Extraction of Tannin from Douglas Fir Bark and Concentration of the Tan Liquor," by E. F. Kurth, J. K. Hubbard, and Maurice Gekeler. *Leather and Shoes* 118, Nos. 20 and 22 (Nov. 1949).
5. "Wax from Douglas Fir Bark," by E. F. Kurth and H. J. Kiefer. *Tappi* 33, No. 4: 183–187 (April, 1950).
6. "The Composition of the Wax in Douglas Fir Bark," by E. F. Kurth. *J. Am. Chem. Soc.* 72: 1685–1687 (April, 1950).
7. "Products Obtained by Destructive Distillation of Douglas Fir Bark," by E. F. Kurth and C. V. S. Ratnam. *Tappi* 33, No. 10: 517–519 (Oct., 1950).
8. "The Chemical Nature of the Cork from Douglas-fir Bark," by H. L. Hergert and E. F. Kurth. *Tappi* 35, No. 2: 59–67 (Feb., 1952).
9. "Dihydroquercetin as an Antioxidant," by E. F. Kurth and F. L. Chan. *J. Am. Oil Chem. Soc.* 28, No. 10: 433–436 (Oct., 1951).
10. "Extraction of Tannin and Dihydroquercetin from Douglas-fir Bark," by E. F. Kurth and F. L. Chan. (In press) *J. Am. Leather Chem. Assoc.*

The Operation of an OCO Water System on a Board Mill's White Water

J. HOWARD WRIGHT

Pulp and paper mills are confronted today with the problem of minimizing or oftentimes eliminating stream pollution. This fact is primarily an outgrowth of the consciousness of the public that surface bodies of water are vital to their general welfare, though sometimes one might feel that the political aspects have a definite bearing on public opinion and reaction.

Pulp and paper mills, being users of extremely large volumes of water in the process work, are confronted with what might seem a Herculean task of reducing the unfavorable characteristics of their water discharged to a receiving body of water to a clarity acceptable to the public and to standards acceptable to the state control divisions, usually the state health department.

Our company operates two paperboard mills which are located at Downingtown, Pa., on the banks of the historic Brandywine Creek. We make a diverse number of boards from chip, news, and kraft secondary fibers. We have been confronted with antistream pollution from way back. Many methods of mill effluent treatment have been explored and tried with varying degrees of success. Up until 1950, no method tried to date completely and continually met the requirements set by the Commonwealth of Pennsylvania.

In late 1949, the decision was made to explore a system of white water clarification which had been developed and installed in the Rittman, Ohio plant of the Ohio Boxboard Co. This system is called the OCO system.

It appeared from knowledge of operational history on that installation, that at last a mechanism was at hand to meet the uncompromising requirements set as a goal.

Based on the experience of the Rittman installation, a survey was made on the white waters of Bicking's no. 2 plant, which produced 65 to 70 tons per day. Survey results indicated that flow rates approximating 10 g.p.h. per sq. ft. of filter surface, using a reasonable amount of filter-aid, could be anticipated on the excess waters in the plant and have a resulting clarity such that its re-use could be substituted wherever fresh water was being used. Further, it indicated that filter cycles of between 8 and 24 hr. could be attained. It also appeared that if we could arrange to pass a maximum of 100 g.p.m. through the proposed filter, we would attain positive assurance of eliminating any process water discharging from the mill.

We had already segregated the high and low-solids waters and divorced the nonprocess waters from the white water system; and, with the use of high-pressure, low-volume showers, we had reduced the use of fresh water to a minimum for better Link-Belt operation. This brought our water system to a point that, outside of a filtered water tank, nothing more was necessary to install the OCO system. So, early in 1950, an order was placed with OCO Systems, Inc., for one complete filter and auxiliaries for immediate delivery. The system was installed and started up in November, 1950.

DESCRIPTION OF EQUIPMENT

Briefly, the OCO system, as installed at Bicking's no. 2 plant, consists of a plate and frame-type filter press built by Valley Foundry, Fresno, Calif.; a centrifugal pump supplied by Mission Mfg. Co., Houston, Tex.; Flowrator and controls supplied by Fischer & Porter Co., Hatboro, Pa.; and filteraid feeder supplied by Syntron, Inc., Homer City, Pa.

The filter press is a 65-chamber unit. All materials coming in contact with the water are of a special cast aluminum alloy. The plates were originally covered with 15-oz. plain weave cotton duck filter cloth. The total filtering area is 1014 sq. ft. A 12-in. diameter hydraulic ram exerts a total force of 70 to 75 tons on the plates. The inlet and outlet of filter are of closed design. A bull's-eye sight glass is incorporated in the discharge manifold so that the clarity of discharge can be inspected at a glance.

The Mission centrifugal pump is now of aluminum bronze trim, open impeller type, designed to pump 300 g.p.m. against 190 T.D.H. at 1750 r.p.m. At maximum output and maximum discharge head, approximately $28^1/_2$ hp. are required.

The Flowrator is of standard design using stainless steel trim. Through compressed air linkage, the Flowrator operates a motor diaphragm valve, thus regulating the flow input to filter press. Facilities for manual control through a motor diaphragm valve are also provided.

The filteraid feeder consists of an 18-cu. ft. steel hopper suspended on wire cables from a steel framework. Two variable frequency vibrating units are affixed to hopper and discharge spout in such a way that arching of filteraid will be suppressed and rate of feed controlled.

PROCESS

High-pressure, low-volume showers are installed on top and bottom felts in such a manner that, when the felt conditioners on top, bottom, and second press felt operate, the total volume is no more than 90 g.p.m. This water, over and above felt carry-over, is accumulated in a separate sump and pumped to a Link-Belt sedimentation system. Here alum is fed to lower pH to an optimum flocculating point. The effluent from the Link-Belt system is collected and discharged into the Mission pump in conjunction with the predetermined amount of filteraid. The Mission pump sends this water slurry through the filter press at a predetermined rate of flow automatically controlled by the Flowrator. The clarified or filtered water discharges into a clear water well of 25,000 gal. capacity. This storage supplies the booster pump system which in turn supplies the water to felt showers at 105 to 110 lb. p.s.i.g. A float-operated make-up valve is installed in clear water well so that, if clarified water supply fails, fresh water is automatically provided.

The system provides a continuous supply of clear, warm water for the felts, thus assuring openness and efficient water removal.

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The white water discharged from the cylinder molds and that discharged by the primary presses is termed "high solids water." This high solids water, separated from the low solids system, is preheated and returned to beater room for use in stock preparation. Installed in the system is a surge tank of 25,000 gal. capacity. This tank acts to level out the peak flows of high solids water and also acts as an accumulating tank to serve stock preparation on start-ups. The system is well supplied with automatic control devices to minimize need for human attention and manipulation. (On rare occasions, it is necessary to bleed high solids water to low solids system. When this happens, it more or less upsets the Link-Belt installation and consequently reflects on the operation of the OCO system. Normally the high solids system is slightly starved.)

When starting the filter press, clear water is recycled through the press with a high flow rate of filteraid. (In our case, we are using Special Speed-Flow Dicalite.)

The filteraid is deposited more or less evenly over the surface of the protective papers. We make and punch these papers ourselves. Originally, we used 32-lb. saturating felt; but, recently we tried 48-lb. indented, and the results were quite satisfactory.

When a good layer of clean filteraid has been deposited, the machine is ready to go on the line. It takes about 150 lb. of filteraid to satisfactorily precoat in about 15 min. time.

Once the machine is on the line, it practically takes care of itself. Initially, we had a man on each shift to observe the operation and to make periodic adjustments. At the end of 3 mo. operation, we eliminated these three men by installing an extension to the Dicalite hopper and an automatic overload pressure switch device (which at a predetermined pressure trips out the Mission pump and the Syntron feeder). We are currently getting by with $^1/_2$ man-day labor over and above what we required prior to OCO installation. (We had a water tender caring for waste water treatment prior to installing the OCO system.)

Under normal conditions, operating cycles of 24 hr. are experienced. We have several 48-hr. cycles; on a couple of occasions we have run 72 hr. Best of all, no water is normally discharged from the mill. When there is a discharge, it is filtered water; unless some unusual circumstance shuts the OCO down.

Seldom does an installation such as described work perfectly at the start. This one was no different.

A chlorinator was included with the original installation but after a period of time it was concluded that the application of chlorine to the filtrate of the OCO system was not the most effective place to use chlorine in the paper machine white water system. The closed white water system promoted microorganism growth in spite of chlorine addition as mentioned.

We found that the filter reduced the microorganism content of the treated white waters up to about 95%. Thus we elected to move the chlorinator and use it to apply chlorine to the back water of each vat fan pump. By supplementing the chlorine with a small amount of phenol mercurial acetate (applied once each shift in each breaker beater) we have effectively controlled odor problems which were serious for a time.

We found it necessary to provide a deaerating device to remove entrained air so that the primary sedimentation system would operate effectively.

The sludge pump was found inadequate. It pumps the filter cake slurry and the sludge drained from Link-Belt to the dirty hot water tank and thence to stock preparation. It is being replaced with a 10 by 4-in. centrifugal sludge pump.

We had hoped to get by without the use of alum. So far it has been necessary to use it for flocculation. We have tried a combination of alum and sodium aluminate but because of the high temperature (110 to 120°F.) of the white water, eddy currents seem to break the floc up and thus disturb the settling of the suspended solids.

We started out operating the OCO system with a cast iron body, cast iron trim slurry pump. Complete failure of the pump was experienced after about 2 months operation. The equipment supplier provided an aluminum bronze casing, aluminum bronze trim pump thereafter. This pump has stood up exceptionally well to date.

We found, too, that the filter cloths and aluminum alloy grid plates were becoming badly incrusted with deposits of precipitated dissolved salts. We had to wire brush the grids completely and put on new cloths in order to obtain a normal 24-hr. throughput. With the assistance of Oakite products, we worked out a cleaning procedure. By using Oakite 84A and recycling with filtered water (110 to 120°F.), we could reduce the pressure drop across filter about 20 lb. in 30 min. time. At the end of a 30-min. clean-up, we simply put the system back on the line.

More recently we have experimented with used top or bottom felts in place of cotton duck cloths. The results have been so satisfactory that we have decided to use old felt as a standard practice. Instead of cleaning felts when dirty, we will simply replace them with more old felts, and sell the dirty felts for salvage as we would have done originally.

Another major problem yet to be satisfactorily solved is the foaming condition around sections of paper machine where filtered OCO water is used. We have tried solutions of foam killers with a degree of success; but so far the results, on a day-in and day-out basis, are not satisfactory. We are working on a plan to flocculate in primary treatment at a pH of 6.0 to 6.5. If this plan is successful, perhaps the high concentration of dissolved solids will be lessened and surface tension of filtered water decreased.

Due principally to the foam problem, we have not been able to complete close the system on the paper machine in recent months. We feel that once the foam problem can be surmounted, we can return to a tightly closed system.

An analysis of the clarified water, brought about by positively closing up the system, for practical purposes, indicated that it contained no suspended solids; that the total dissolved solids ranged between 11,000 and 13,550 p.p.m.; and that the 5-day B.O.D. exceeded 3500 p.p.m. A chemical analysis of a sample taken after 45 days' continuous operation showed:

	P.p.m.
Total hardness as $CaCO_3$	1170
Calcium as $CaCO_3$	1096
Magnesium as $CaCO_3$	74
Phenolphthalein alkalinity as $CaCO_3$	0
Methyl Orange alkalinity as $CaCO_3$	160
Sulphate as SO_4	1640
Chloride as Cl	336
pH	5.5
Total iron as Fe	12

Note: Clarified water treated with as high as 45 lb. Cl_2 per day without any signs of a residual at the extremity of the system.

What is there on the plus side of the ledger since the installation of OCO system as compared with operation previous to the installation?

Taking the months of September and August, 1950, as normal for the time prior to the OCO installation, and December, 1950, and January, 1951, as typical of operation since OCO installation (the OCO went on line steady Dec. 1, 1950), the figures reveal:

	August, 1950	*September, 1951*	*December, 1951*	*January, 1951*
Total suspended solids in effluent, lb. per 1000 gal.	0.30	0.34	None	None
Total gal.	4,220,300	3,835,900	21,800	17,900

	August, 1950	September, 1951	December, 1951	January, 1951
Weight of suspended matter lost, lb.	1,265	1,305	None	None
Alum used, lb.	21,950	26,650	13,000	11,100
Dicalite used, lb.	None	None	19,550	17,100

The cost of the Dicalite approximates $70 per ton. As 100% of it is recovered in the end product, based on present market conditions, there is a substantial profit in that direction.

With the OCO system operating, shower water is available at 100 to 110°F. without the use of induced heat.

Assuming the mean annual temperature of our fresh water to be 50°F. and the use of 120,000 gal. of shower water a day—the shower water being used over and over after clarification when the OCO system is running—there is a saving of 50,000 to 60,000 lb. of steam per day. That saving in itself is a sizable advantage.

We also have reason to believe that the filtered low pH water does a better job of keeping the felts clean than does fresh water. The fresh water, likewise, would be much colder than the filtered water except when induced heat was applied.

CONCLUSION

Based on our experience with the OCO system, the following facts can be set forth:

1. Closing up of our paper mill water system promotes: (a) build-up of dissolved solids, (b) necessity for microorganisms control, (c) increased total acidities, and (d) foam problems.
2. Old top and bottom felts can be used for filter cloth.
3. Alum treatment costs are materially reduced.
4. Substantial heat savings are realized.
5. Felts are kept as clean or cleaner than when fresh water was used.
6. Stream pollution is cut to very minimum.

Kraft Mill Effluents

A. W. PESCH

The kraft, or sulphate, process is the youngest of the three major methods for making chemical wood pulp. It originated in Europe in 1879 as an accidental offshoot of the soda process. Commercial production of sulphate pulp in North America did not begin until 1907 when Brompton Pulp & Paper Co. introduced the process into its mill at East Angus, Que. Production in the United States began in 1908. The first kraft mill in the South was Orange Pulp and Paper Mills, Orange, Tex.; this mill began making pine soda pulp in 1910 but soon changed to the sulphate process. The subsequent growth of the kraft industry in the United States has been phenomenal, particularly in the South.

Many factors and developments account for this growth. Of basic importance are the characteristic papermaking strength of kraft pulps and the fact that the process is more generally applicable to all species of wood than any other pulping process. Its uses for wrapping papers and for grocer bags accounted for the original growth. To a large extent cloth bags and wooden barrels have been replaced by kraft multiwall sacks for the shipment of portland cement and many other bulk commodities. Sulphate pulp was once regarded as too difficult to bleach. Significant developments in bleaching techniques have changed this picture completely and many grades of white paper, including fine papers, are now made entirely or partly from bleached sulphate. But paper shipping containers now constitute the largest single application for kraft pulp and they account for most of the kraft industry's growth since 1930. Boxes made from kraft paperboard have largely replaced the wooden box as the standard shipping container because, for the handling of most commodities, they cost less, weigh less, and carry their contents to destination in better condition than wooden boxes. It requires less wood to produce a kraft shipping container than what is needed to make a wooden box for the same job. Many kraft boxes, after use, are salvaged and made into new paper for new boxes. The salvaging of wooden boxes for re-use is economically impossible in almost every instance. One could go on citing cases where kraft products have met the needs of the expanding economy; but the underlying reason for the tremendous growth of the kraft industry is because its many products have served those needs adequately and economically, and with a minimum drain on the natural resources.

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The supply of pulpwood obviously is the primary factor that determines the initial location and the possible later expansion of an integrated kraft paper or paperboard mill. But water is the medium in which almost all the chemical and mechanical operations of pulp and papermaking must be conducted. Relatively large volumes of fresh water, both as a raw material and as an indispensable working tool, must be used. Therefore an adequate supply of suitable fresh water is of utmost importance to every pulp and paper mill. The development and installation of the water supply facilities constitute a substantial part of the total cost of a kraft mill. The operating cost, including maintenance, of the water supply system constitutes an important direct charge against everything made. When a mill is equipped with modern high-pressure boilers, or if it manufactures bleached pulp or paper, then chemical treatment of the raw fresh water is usually required. Chemical treatment adds materially to both the capital cost and the operating cost.

The total capital and operating costs for fresh water at a given mill site are approximately proportional to the total consumption of fresh water. Thus, under given conditions, the total fresh water cost per ton of paper or board is proportional to the gallons of fresh water consumed per ton of paper or board produced. In a highly competitive industry such as the paper industry, manufacturing costs are very important. The bare cost of the water that must be used is the initial reason behind the constant effort to reduce fresh water consumption to the minimum point consistent with good mill operation.

Most of the fresh water used eventually leaves the plant as mill effluent. Unfortunately, in spite of the great strides that have been made in kraft mill waste reduction, relatively small portions of wood residues and chemical residues are retained in the effluents that must be discharged to the receiving stream or tidewater. The wastes contained in the effluents constitute an economic loss because they represent purchased raw materials, potential by-products, and lost pulp and paper production. Therefore, there is every reason to continue striving for waste reduction and waste elimination since it is known that the use of unneeded fresh water tends to increase the losses from the mill and the cost of the waste disposal facilities required. Those are added reasons for holding fresh water consumption to the lowest practicable minimum.

Conservation of natural resources has become a major problem in the United States. It will become more and more important as the growing population increases the demand on those resources. Pulpwood has become relatively expensive everywhere and scarce in many areas. Present restrictions on the use of elemental sulphur are an example of the governmental regulation that follows whenever the current demand endangers the future supply of an essential commodity. The growing number of Federal and State laws regarding waste disposal is a sign of the times. While agitation by pressure groups and political maneuvering often play a leading part, legislation on stream pollution control does stem from

public concern about the conservation of water resources and recreational facilities.

Conservation of natural resources does not mean the nonuse of those resources. Waste disposal is one of the natural functions of streams. Every stream is capable of absorbing a certain amount of waste, either natural or man-made, without damage to the stream or to the public interest. The process of aeration and biochemical oxidation which is at work in all streams and tidal waters, soon returns the water to its original condition unless the pollutional load imposed by nature, and by man, exceeds the recovery capacity of the stream or tidal area concerned. Present-day civilization, with its concentrations of population and its industries, must utilize the waste disposal resources of its streams. This need is recognized by many eminent authorities in the field of stream sanitation. But, while the pulp and paper industry needs to utilize the streams for the disposal of its effluents, it is appreciated that it must so control and handle its effluents that pollution of the receiving waters is avoided.

The management of the pulp and paper industry recognizes its responsibilities regarding conservation and is anxious to solve all of its waste disposal problems. This attitude led to the formation, in 1944, of the National Council for Stream Improvement (of the Pulp, Paper, and Paperboard Industries). Membership in the National Council is confined to the pulp and paper manufacturers of the United States. Dues are assessed against the member mills on the basis of the kind and quantity of pulp and paper they produce. The National Council is not permitted to engage in political activities. Its primary function is to initiate, direct, and conduct technical studies and research work on the effluents from the various processes of the pulp and paper industry. Waste reduction at the source, recovery of wastes for re-use or as by-products, and the development of adequate and economically feasible methods of effluent handling or treatment, are the objectives of this coordinated industry-wide program. Field studies on the waste disposal capacities of the receiving waters and stream surveys, should undesirable local conditions develop at any of the member mills, are an integral part of the duties of the National Council's technical staff. The research and field work budget for the year 1952 is well over $100,000. Over 80% of the total production capacity of all the integrated kraft mills is included in the National Council membership.

The National Council's work on kraft mill effluents is centered in a research project that was placed with the Engineering Experiment Station of Louisiana State University at Baton Rouge. Said project has been operated on a full-time basis since November, 1946. William A. Moggio, Resident Engineer, National Council for Stream Improvement, H. A. Flanakin, Director, Engineering Experiment Station, Louisiana State University, and Harry W. Gehm, Technical Adviser, National Council for Stream Improvement, are in immediate charge of this work. The first undertaking was a laboratory study of the biochemical oxidation characteristics of kraft black liquor residues. The diffuser tail water was the effluent that was chosen for the initial work. Because of the continued trend from diffusers to rotary vacuum filters for kraft pulp washing, the investigation was soon diverted to a study of the more voluminous effluent from the wet machine room. The latter contains a much lower concentration of black liquor than diffuser effluent.

The L.S.U. laboratory studies on the waste waters from the wet machine room indicated that biochemical treatment of said effluent, or of the combined outfall from a kraft mill, might be effective. A modification of the domestic sewage activated sludge process reduced the B.O.D. content of these effluents effectively under laboratory conditions, but extensive pilot plant studies at an actual kraft mill were needed in order to determine optimum treatment conditions, type and size of equipment required, and the capital and operating costs involved. Accordingly the kraft member mills in the South contributed a fund of approximately $10,000 toward the construction of an adequate pilot plant at one of the Southern mills. The pilot plant was built in 1951 by Macon Kraft Co., Macon, Ga.

The members of the Southern Regional Technical Subcommittee of the National Council met at Macon in October, 1951, and satisfied themselves that the pilot plant was adequate in every respect. The Macon pilot plant has been operated continuously during the period October, 1951, to October, 1952. The Macon Kraft Co. has supplied the technical and other operating personnel. Engineers on the technical staff of the National Council have guided and supervised the pilot plant studies and one of these engineers has been in Macon much of the time. The pilot plant work has included aeration of the incoming mill effluent with compressed air, initial seeding with sewage plant sludge in order to introduce the desired types of bioorganisms on which the functioning of the activated sludge process depends, addition of nutrients such as nitrogen and phosphates to accelerate the growth and activity of the bioorganisms, detention of the treated effluent in the pilot plant reaction tank in order to determine the time interval and tank capacity required for effective reduction of the B.O.D. content, separation of the activated sludge produced before discharging the treated effluent to the mill outfall, and return of a portion of the activated sludge for seeding the incoming mill effluent.

This series of studies at Macon have been completed. The results look encouraging. A report on this work is now being prepared by the National Council.

It has been known for some years that when kraft mill effluents are treated with soluble calcium compounds, the soluble sodium-lignin black liquor residues will react readily with calcium ions to produce an insoluble calcium-lignin complex which precipitates from the body of the effluent as a sludge. Part of the B.O.D. and much of the color can be removed from kraft mill effluents in this manner. Calcium oxide, i.e. lime, is the cheapest effective form of calcium. Unfortunately the poor settling and filtering properties of the precipitated lime-lignin sludge have interfered seriously with the progress made thus far with this process during extensive laboratory and pilot plant studies at the Springhill mill of International Paper Co. Also, before the lime treatment of kraft mill effluents can be considered practicable, an economical method of recovering the lime from the sludge must be found. The dewatering, drying, and proposed calcining of the sludge all involve serious unsolved problems. The characteristics of the organic matter in the sludge are the chief factor in all of these difficulties. The National Council research project at L.S.U. is currently engaged with laboratory studies on the lime treatment process.

While we are very anxious to find complete and final solutions to the effluent disposal problems, we are proud of what we have accomplished on kraft mill waste reduction and pollution abatement. The author will cite a few examples.

At some of the early mills the bark from the pulpwood was discarded to the streams as waste, other mills burned it in refuse burners; today every mill uses its bark as boiler fuel. The bark from 1 cord of rough wood is equivalent in fuel value to around 300 lb. of good coal. The total amount of lime required in the caustic room normally averages between 400 and 500 lb. per ton of pulp. All kraft mills used new lime exclusively until about 1928 and most of them discarded the calcium carbonate sludge to the river as waste. Since then a great many kraft mills have installed equipment for calcining the sludge; most of these mills now recover from about 80 to over 95% of their total caustic room lime requirement. Fiber losses from the pulp mill, and from the paper mill, have been reduced materially by the installation of more efficient saveall equipment and by extending the re-use of whiter water in place of fresh water.

With regard to pollution abatement, however, the most important development has been the substantial reduction in

black liquor losses during pulp manufacture. The amount of white liquor that must be charged into the digesters depends on a number of variables but principally on the type of wood cooked and the grade of pulp produced. At most mills the total soda content of the white liquor to the digesters lies between 1500 and 2000 lb. of salt cake equivalent per ton of air dry unbleached pulp produced. The salt cake added as make-up in the recovery room is the measure of the total soda losses from the entire pulp mill; all the remaining white liquor soda is recovered from the black liquor. Many typical kraft mills now use less than 200 lb. of make-up salt cake per ton of pulp; a few mills have reduced their salt cake consumption to where it now averages about 100 to 125 lb. per ton. If, as a typical example of present practice, it is assumed that the soda content of the white liquor to the digesters is equivalent to 1800 lb. of salt cake per ton of pulp, and that the salt cake make-up is 150 lb. per ton, then the soda recovered from the black liquor is approximately 1800 − 150, or 1650 lb. of salt cake equivalent per ton of pulp. Expressing this same typical performance in another way, the digester soda recovered from the black liquor is approximately equal to $(1650 \times 100)/1800$ or about 92% of the total soda charged into the digesters as white liquor. But a small portion of the soda in the make-up salt cake is lost before it reaches the digesters; also a substantial part of the remaining total soda looses are those from the electrostatic precipitators, and from the caustic room and lime kilns—all of them losses which occur after the organic matter has been burned out of the black liquor in the recovery furnaces. On this basis we are justified in claiming that many kraft mills are now recovering and utilizing as recovery furnace fuel, around 95% of the total black liquor that is produced. During the early 1920's the total soda losses at most kraft mills averaged from 400 to 600 lb. of salt cake per ton of pulp; some mills at that time had salt cake losses between 600 and 800 lb. per ton. Electrostatic precipitators on the recovery furnace flue gases are a relatively new development and they have reduced the salt cake losses by approximately 100 lb. per ton of pulp. The bulk of the lowered salt cake consumption is, however, due to the greatly reduced losses of black liquor from the process. Improved and more adequate equipment, especially in the washer room, evaporator room, and recovery room, accounts for most of the reduction in black liquor losses. These developments have entailed heavy capital expenditures and a great deal of hard work by the kraft industry and by equipment manufacturers. Inasmuch as black liquor constitutes the bulk of the B. O. D. content of kraft mill effluents, the drastic reduction in the black liquor losses just described has minimized, or substantially solved, the effluent disposal problem at most kraft mills. In practically every instance these improvements have paid for themselves and we are confident that further developments in process equipment and mill design will continue to contribute toward the full solution of the kraft mill waste disposal problem.

Several important instances are cited where, because of recent and current developments, further reductions in kraft mill effluent losses may be expected. Waste elimination at the source—to whatever extent it is possible to find methods that are technically effective and economically practicable—is always a sound approach to the solving of a waste disposal problem.

Washer Room Losses. Washing the pulp to maximum cleanliness and complete recovery of the black liquor at minimum dilution are the objectives of every washer room. Good technical results can be obtained with diffusers provided that the diffuser installation has ample capacity. The capital and operating costs of an ample diffuser installation today are relatively so much higher, however, that rotary vacuum washers, or screw presses, have replaced diffusers in many instances. With screw presses and filters it is relatively easy to eliminate the direct losses of black liquor to the sewer; but sound engineering and adequate capacity are of the utmost importance so far as clean pulp and minimum black liquor dilution are concerned. Adequate foam control is essential. Experience with screw presses is still limited. On the basis of recent developments in the design and application of filters, and because of the competition between screw presses and filters, there is every reason to expect further increases in the percentage of black liquor recovered from the pulp.

Evaporator Room Losses. With the older types of multiple effect evaporators, entrainment and carryover often constituted the largest single loss of black liquor from the mill. The long tube vertical film-type evaporator has become the prevailing design in the kraft industry since 1935; it has been developed to where liquor losses from the evaporator room no longer constitute an important problem. Some black liquor may be lost from the last effect because the high vapor velocities leaving said effect make it difficult to design an efficient and practicable catchall for that point. Providing and maintaining ample evaporator capacity is obviously essential. Complete removal of the pulp from the feed liquor materially reduces fouling of the heating surfaces. When cooking resinous woods, fouling is materially reduced if the black liquor soap is removed from the partially concentrated liquor.

Paper Mill Fiber Losses. The rotary vacuum saveall has been an effective tool in the campaign to reduce fiber losses. During prolonged periods of trouble at the wet end of a paper machine, however, the capacity of the normal saveall system is apt to become overloaded. Some mills have installed storage tank facilities into which they pump the wet broke from the couch pit during such emergencies. After the paper machine troubles have been overcome, the stock concerned can be returned to the regular stock system gradually. Effective slime control helps to reduce fiber losses because it reduces wet end breaks and extends the degree to which fresh water may be replaced with paper machine white water.

As technical men it is our duty to supply management with adequate data on the amount of fresh water consumed, on the volume and analysis of the effluents from the various mill departments, and on the condition of the receiving waters. This requires adequate measuring and sampling devices. Flowmeters on the effluent sewers are desirable. Recorders utilizing electrical conductivity principles are an effective aid for controlling liquor losses because they show immediately when undue losses are occurring.

Locally undesirable conditions can sometimes be avoided by discharging the effluents in a manner that promotes rapid and thorough mixing with the receiving water. At two of the International Paper Co. mills the total mill effluent is discharged into relatively deep water through long underwater pipe lines. One of these mills is on tidewater, the other on a river. The higher temperature of the effluent, compared to the receiving water, prevents stratification and aids rapid mixing. If such long effluent discharge lines are provided with numerous side outlets, the effluent is dispersed over a relatively large area at the outset.

Where the waste disposal capacity of the receiving water is relatively small, either because it is a small stream or during abnormally low rates of stream flow, then pollution can be avoided by impounding part or all of the mill effluent and discharging it to the stream later, either continuously in accordance with permissible dilution ratios or periodically during high water runoff periods.

Referring back to possible chemical and biochemical methods of treating kraft mill wastes, the author would like to conclude by pointing out the need for making haste carefully in order to avoid wasting natural resources and company capital on treatment plants which may not do the job adequately or which may soon become obsolete.

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Recovery Operation Corrosion Problems

H. O. TEEPLE

When this assignment was accepted, it was indicated that these comments should cover primarily the recovery furnace, boiler and auxiliaries. These latter would include dissolving tank, liquor spouts, induced draft fans, salt cake mixing tank, disk evaporators, and duct work.

In considering what might be offered in the way of enlightening remarks on this subject, it was apparent that not much has been published on the subject. Further, during frequent conversations with pulp mill people, the subject has not come up for much discussion. Therefore, it could be assumed that, generally speaking, corrosion problems are perhaps not as bothersome as such problems are elsewhere in the pulp mill. While this may be a true assumption, it still probably is a good idea to consider these operations from a corrosion viewpoint.

Perhaps we could begin with a discussion of the salt cake dissolving tank. These tanks are usually made of carbon steel plate of appreciable thickness, say $^1/_4$ to $^3/_8$ in. An agitator is used which serves to assist in the solution of the crushed salt cake in the heavy black liquor at about 200°F. As far as weight loss corrosion rates are concerned, carbon steel is probably quite adequate. However, as many know, this is not the whole problem. Abrasion also is involved to a considerable extent. Usually this occurs on the sidewalls of the tank, perhaps a foot or two up from the bottom. Also there has been some but perhaps not quite as serious abrasion of the agitator arms. There seem to be some practical solutions to this problem. Perhaps one economical solution would be to use replaceable carbon steel wear plates around the sidewalls of the tank. Another possible solution would be the use of stainless clad steel wear plates. Similar suggestions probably would suffice for the bottom in the event considerable abrasion occurred there. It probably would not be necessary to make the whole tank out of stainless clad steel.

Most of the agitating equipment appears to be made of carbon steel. It is probably neither difficult nor expensive to replace this equipment from time to time.

In the event iron pumps used to transfer the heavy black liquor with the dissolved salt cake to the recovery furnace do not show an economical service life, the use of stainless pumps or Ni-resist pumps would serve to alleviate some of the problems. The use of black iron pipe for transfer lines appears to be economical.

Now moving along to the recovery boiler itself, it appears that carbon steel tubes are adequate for the steam temperatures and pressures commonly encountered. If corrosion problems occur, it would be well to check with the boiler manufacturers as they have accumulated a considerable amount of experience upon which a reasonable discussion of the troubles encountered can be based.

As the smelt leaves the boiler, a corrosion problem associated with the smelter spouts has been frequently encountered. The solution to this problem is not too difficult if one will consider carefully the existent facts. It may be that carbon steel spouts are wearing out frequently and perhaps the reason is that the cooling water used is such that a scale builds upon the interior of the spout thus decreasing considerably the heat transfer rate. A switch to steam condensate will alleviate this situation. In the event the use of stainless steel seems to be indicated, a number of compositions are available depending upon the severity of the situation. Generally 18–8 stainless is satisfactory although 25–12 (type 309) or 25–20 (type 310) may be required. Some spouts are ceramic lined which has worked out satisfactorily in a number of cases.

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The smelt tank is generally made of carbon steel. Aside from cracking sometimes observed at or in the welds, an economical solution to the corrosion of the tank itself would be the incorporation of a corrosion allowance factor in terms of heavy gage plate used for the tank. Similar comments could be offered with respect to smelt tank agitators.

Perhaps now we should consider flue gas duct work and induced draft fans. As the flue gas leaves the furnace the sulphur content of the gas is high. This sulphur is largely present in the form of sulphur dioxide. If it is possible to keep the stack gas temperature well above the dew point, the corrosion problems are not as severe as they would be otherwise. Therefore, in some cases it is wise to insulate portions of the carbon steel ductwork. There has been some interest in the past in the use of stainless steel for flue gas ducts. This may not turn out to be a reasonably good economic solution to the problem because of several good reasons. First, if any stainless is to be considered it probably should be type 316. The 18–8 stainless would not be expected to be sufficiently resistant to pitting attack if the gas temperature fell below the dew point. While type 316 stainless would be preferable because of its greater resistance to pitting under these circumstances, the fact that the flue gas always contains solids would limit the usefulness of this steel. In hot wet sulphurous acid conditions, which incidentally may also include some appreciable quantities of sulphuric acid, the precipitation or settling out of the solids will generally result in crevice corrosion, i.e., pitting and possible perforation of the stainless, even type 316 stainless.

It would appear that these comments on ductwork would apply to induced draft fans. If the system is tight and not many air leaks occur, the carbon steel should perform rather well provided the temperature of the gas is maintained well above the dew point. Insulation of the fan housing should be effective. It is pertinent to point out that operational techniques may be responsible for some of the corrosion—mainly because too much heat is extracted from the gas.

In considering corrosion problems associated with precipitators, an analysis of the situation would reveal the corrosive environment is a combination of high moisture content of the gases, an oxidizing atmosphere, sulphur dioxide, possibly sodium chloride (*1*), and temperature. It is believed that electrostatic precipitators catalytically oxidize some sulphur dioxide to sulphur trioxide, thus increasing the sulphuric acid content of the gas which would aggravate the corrosion problem, if operation below the dew point is encountered.

Generally speaking, the corrosion of the carbon steel components of a precipitator can be minimized if attention is paid to the maintenance of adequate temperatures within the precipitator. As was mentioned above, in the case of duct work, the gases can be quite corrosive if the temperature falls below the dew point. This is particularly true if the steel hoppers of a dry bottom precipitator are not properly insulated and/or are not properly heated (*2*). The precipitator inlet gas temperature ranges from 260 to 290°F. in some mills with outlet temperatures ranging from 250 to 285°F. The dew points of these gases may range from 135 to 170°F. which are appreciably below the outlet temperatures. However, in localized cold spots some corrosion may be encountered. In some cases air leaks occur which would tend to lower the over-all temperature of the gases thus decreasing the differential between gas temperature and the dew point.

With respect to wet bottom precipitators, carbon steel is usually used for the liquor sump or tank through which the black liquor flows from the recovery evaporators. While this type of a precipitator has only recently been used (*3*) it appears that carbon steel is adequate for the job. Presumably, if difficulties are encountered some relief could be obtained by using the principle of corrosion allowance for the steel bottom. There may be some problem associated with the rotary agitators but probably this can be solved easily with stainless steel if the economics permit.

Another method of recovery chemicals from the recovery furnace gas is by means of a venturi scrubber. A good description of the corrosion problems associated with this type scrubber was presented by Collins and West (*4*). While some difficulty was experienced with carbon steel and subsequently type 304 stainless, it was apparent if normal conditions prevailed, the corrosion would have been less severe. Some of the conditions which prevailed during the initial start-up of the venturi scrubber were associated with a peculiar salt cake make-up problem. As has been pointed out earlier, the drop of the gas temperature below the dew point was a primary cause of much of the corrosion experienced.

Now with reference to auxiliary evaporator equipment (*5*) there are two types: one is the cascade or disk evaporator and the other is the cyclonic evaporator. Generally, either evaporator is fed with black liquor from the multiple effect tubular evaporators or with liquor from the wet bottom precipitator. The evaporator elements are carbon steel which either dips into the liquor or is sprayed by the liquor. The hot furnaces gases enter at 600 to 650°F. and pass over the wetted elements of the auxiliary evaporator thus effecting evaporation. It is important to control the operation so that the temperature of the gas is sufficiently high to provide a safe temperature differential for the fan and/or precipitator *re* the dew point. Generally the exit temperature of the gas is 275 to 300°F.

Perhaps it might be appropriate to mention briefly the oxidation of black liquor. Probably carbon steel would suffice for most of the equipment primarily based upon the fact that weak liquor is usually used (*6*). As more mills utilize this method of achieving a better balance between soda and sulphur values in recovery operations, experience will provide opportunities to evaluate such corrosion problems as may occur.

This discussion of recovery operation corrosion problems has largely been based upon carbon steel as far as materials of construction are concerned. This is believed to be a reasonable approach since experience has largely indicated carbon steel to be suitable.

Since many of the situations wherein corrosion is severe can be corrected by changes in operating techniques, it follows that some attention should be paid this method of alleviating the corrosion problems which arise. Obviously, some conditions may prevail wherein the use of alloys is required. For example, in the gas phase probably type 316 stainless is the first choice, particularly where temperatures in the close proximity of the dew point are encountered. Please note, however, this alloy may not be adequate if solids and/or sulphurous and sulphuric acid are involved. There are probably some cases wherein type 304 stainless will suffice but caution is indicated. The chromium-iron stainless steels would be expected to have little, if any, application. Other alloys such as copper-base, some nickel-base, and aluminum alloys probably would have little application, particularly where sulphurous acid is encountered. In those instances where the use of alloy is not satisfactory it generally means the only solution to the corrosion problem is a change in the operation or the design of the equipment.

In summary, it has been recognized (*7*) that the heat-absorption elements should be integrated. In designing the recovery unit and selecting the various component parts, it should be borne in mind that the objectives of such equipment as may be installed following the boiler are four fold:

1. To recover or utilize as much as possible the heat content of the gases.
2. To reduce the gases to a temperature condition suitable for the fume recovery equipment.
3. To recover the chemical fume carried in the stack gases.
4. To concentrate the heavy black liquor to a suitable consistency, as may be dictated by furnace requirements. It is desirable to add a fifth objective as follows:
5. To design the integrated operation such that operating temperatures are safely above the dew point of the gas in an effort to alleviate serious corrosion problems.

As a final suggestion, perhaps it would be well for those mills which seem to be encountering recovery operation corrosion problems that a critical review of the situation be made, in which case it is hoped these remarks will prove helpful.

LITERATURE CITED

1. Patterson, M. E., and Lloyd, D. B., *Paper Trade J.* 129, No. 18: 33–35 (1949).
2. Roberts, L. M., Beaver, C. E., and Blessing, W. H., *Paper Trade J.* 127, No. 18: *TS*, pp. 439–443 (1948).
3. *Paper Ind.* 34, No. 7: 833 (1952).
4. Collins, T. T., Jr., and West, P. H., *Paper Trade J.* 129, No. 9: *TS*, pp. 320–323 (1949); 129, No. 10: *TS*, pp. 328–332 (1949).
5. Westbrook, U. J., *Paper Trade J.* 131, No. 17: 26–28 (1950).
6. Trobeck, K. C., *Paper Trade J.* 135, No. 1: 27–31 (1952).
7. "Pulp and Paper Manufacture—Preparation and Treatment of Wood Pulp," vol. I, pages 581–582, New York, N. Y., McGraw-Hill Book Co., Inc., 1950.

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The Determination of Total Gas in Stock

J. D. BOADWAY

The existence of gas in stock suspension in three states, as gas bubbles, gas in solution, and gas absorbed on fibers, has been confirmed as reported in a recent paper (*1*).

The method (*2*) described in the literature for determining gas in stock determines the volume of gas bubbles and, as such, is a valuable method for assessing froth troubles, but will not give any indication of the gas in the other physical states.

For the above investigation it was found necessary to use a novel experimental method to determine the total gas content.

The determination of total gas was made by removing the gas from the stock by vacuum distillation and evaluating the volume removed as a change in the absolute pressure of the vacuum system. The equipment for making this determination is shown in Fig. 1. Two flasks, A and B, are evacuated, then isolated by closing valve 2; valve 3 is then closed and the water in flask B boils until the pressure reaches the vapor pressure of water at the temperature of the bath. This pressure will give a reading on a differential water gage with a sealed arm. Valve 3 is then opened and a known volume of stock at a temperature 20°C. above the bath of flask B is admitted to flask A through valve 1. This stock boils as it impinges on the wall of flask A and the gases are thus removed and flushed out by steam. Excessive distillation of water into flask B may be avoided by restricting the flow between the flasks by a medium-sized capillary tube. Valve 3 is then closed and after a period has elapsed for temperature equilibrium to be established in flask B the increase in pressure due to the partial pressure of gas extracted may be noted by reading the differential water gage. The per cent by volume of gas in the stock at atmospheric pressure may be calculated according to the following equation:

$$V\% = \frac{d}{10.25} \times \frac{(Va + Vb) - (Vs + Vw)}{Vs}$$

where

d = difference in gage readings, cm.
Va = volume of flask A
Vb = volume of flask B
Vs = volume of stock used in test
Vw = volume of water in flask B

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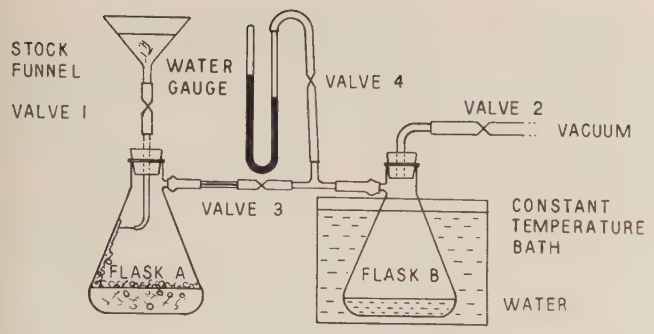

Fig. 1. Apparatus for determination of gas content

Since all the volumes may be standardized in a laboratory, the volume of gas may be simply calculated in practice by multiplying the difference in gage readings by the correct factor.

The method as described is only suitable for studying stable gas in stock since the unstable gas would be lost during transportation to the laboratory and addition to the vacuum system. This difficulty could be overcome by taking samples in the plant in sealed pipets and allowing the entire contents to be drawn into flask A.

LITERATURE CITED

1. Freeman H., and Boadway J. D., *Tappi* 36, No. 5: 236–240, (May, 1953).
2. Smith R. E., Hughson, G. D., and Duncan, R. D., *Pulp Paper Mag. Canada* 52, No. 5: 107–108, 110 (1951).

The Kraft Liquor Cycle from an Operator's Viewpoint

J. L. BROWN

Although the fundamental purpose of pulping wood chips by the sulphate process is to produce a cellulose fiber for papermaking or dissolving purposes, the recovery and conversion of the spent cooking liquors is of no less importance. If these spent chemicals are not recovered, as is the case in the sulphite industry, then the kraft industry would not have the competitive advantage that it does in the pulp-making industry. It is partly through the ability of the kraft industry to recover and reconvert the spent cooking liquors that this industry has had an unprecedented growth.

Although the kraft industry dates back to 1879, when Dahl (pronounced "doll") in Danzig, modified the soda process by adding sodium sulphite to the digesters for cooking wood chips, the present-day concept of chemical recovery is a relatively recent development. For instance, the modern recovery furnace is less than 20 years old and yet today's units are easily operated and most efficient. It is not proposed to discuss history, economics, equipment design, or improvement of the kraft process but rather practical operation of an average liquor cycle, as the process is so commonly called.

PROCESS

It is not necessary to discuss the fundamental principles of liquor cycle operations. However, the author would like to make a few observations in order to define the scope of the paper. Black liquor from the wash room is usually delivered to the evaporator or feed liquor tanks at about 15 to 18% solids and at a temperature up to 190°F. This is the material with which the liquor cycle operators work. It is their job to concentrate the black liquor by evaporating some of the water in it through multiple effect evaporators, to concentrate this black liquor further by utilizing the waste heat from the recovery units, and to burn the concentrated liquor at 60 to 65% solids, and in some cases, slightly higher, in the recovery units where the sodium organic compounds are converted to sodium carbonate and sodium sulphide. It is at this point that the make-up chemical, usually in the form of sodium sulphate, is added to the system.

The smelt produced by the recovery units is dissolved in weak wash to form green liquor. The green liquor is then clarified and converted into active chemicals by reacting it with lime. The clarified white liquor is now ready for use in the digesters to produce more pulp. The conversion of green to white liquor with hydrated lime produces a calcium carbonate sludge which after dewatering can be recalcined back into lime.

The efficiency by which these operations are carried out has a direct bearing upon the cost of the finished pulp. The liquor cycle is an integral part of the pulping process and the success with which it is operated reflects itself into pulp cost and quality. Costs can be lowered by high conversion efficiency and quality stabilized by uniformity of operations.

EQUIPMENT

To do the job assigned to the liquor cycle requires a vast amount of expensive equipment. This equipment is quite well standardized and can be purchased from any of many reputable manufacturers. However, the final selection of any piece of liquor cycle equipment depends upon the following factors: (1) initial cost, (2) operating efficiencies, (3) continuity of operations, and (4) maintenance requirements.

These factors will be developed further but before doing so the importance of sizing the equipment correctly will be discussed briefly. It is the job of management to purchase equipment properly balanced to give maximum efficiencies with a minimum outlay of capital money. Their decisions in these matters are usually influenced considerably by the advice of the experienced operators. However, it is natural for the operating department to recommend oversize equipment. This normal reaction on the part of the operators is because they, more than anyone else, realize the advantages of flexibility of operation, low maintenance, and high efficiencies which can be derived from units in which a moderate safety factor has been built. The operators know, and it has been proved many times, that production tomorrow will be higher than management can foresee today. Therefore, the department having the extra large equipment is usually capable of handling the increased flows without the sacrifice of over-all efficiencies and the increased maintenance which usually follows. However, a mill which is overcapitalized is usually a high-cost mill, and management is quite hesitant to build into a mill more equipment than is actually needed. Therefore, it is a sign of good management when a mill finds itself completely in balance regarding equipment size and efficiencies.

Let us consider for a minute the cost of liquor cycle equipment. The initial cost does not always tell the whole story. For the operating mill whose inefficiencies are due to worn-out or outdated equipment, the factor of equipment delivery is most important. In this case, a sum of money must be added to the initial cost of the equipment equivalent to the higher cost of production which will exist between the time that the new equipment is ordered and the time when it is on the line and operating efficiently. This may appear on the surface to be inconsequential, but a little figuring will quickly show that a delay in delivery, of say 3 months, will increase pulp cost during this period considerably.

It is well known that the equipment industry is highly competitive. Even though this is true, and a piece of equipment appears to be well constructed and to include the latest design for maximum efficiencies, it is well that the engineers and operators check and recheck it for weak points and bottlenecks. Whenever possible, a proposed piece of equipment should be seen in operation, and performance data collected

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so that the true facts are known. After all, this is the only method by which the equipment can be really evaluated.

Unless one is buying a duplicate of some existing piece of equipment in the mill, it is well to study the proposed installation for efficiencies and ease of operation. After all, the job can be done with many types of equipment, but the best job is usually the one in which the units are run continuously at the highest efficiencies and the least maintenance. Without continuous operation, even though the interruptions may be legitimately justified, the cost will go up. It is the "old reliable" in equipment that pays off. Maintenance cannot be controlled if the equipment does not operate continuously whether for reasons of poor selection, faulty controls, insufficient maintenance, or inadequate design.

ARRANGEMENT

The third item is the arrangement of the various operating units. Specifically, we are discussing the evaporators, the recovery furnaces, the clarifiers, causticizers, and lime kilns. These units, with their supporting equipment of pumps, pipe lines, and storage tanks, represent a vast outlay of capital dollars and could be called the bread basket of sulphate pulping. It is only through a balanced operation of the many phases of liquor cycle operation that the kraft pulp industry is a profitable one. The responsibilities of the individual operators are profound, but only completely effective if their activities are well coordinated by perfect planning and over-all supervision. The total cost of the various operations, and the effectiveness with which they function, can be influenced appreciably by the physical arrangement of the various units.

Modern design and layout of the liquor cycle equipment have shown great progress. The new mills, recently placed into operation or still on the drawing board, are taking full advantage of consolidating all related equipment for better over-all control and lower man-hours.

In the older mills, the layout of equipment is, in some cases, quite haphazard and presents a real problem of communications. Not only is it most difficult for each operator to keep in touch with the others, but the problem of liquor transfer presents some difficulty. Some of these difficulties have been overcome by the ingenuity of the pulp mill engineers and maintenance men. For instance, flow troughs properly designed to be self cleaning have, in most cases, replaced standard methods of piping for the transfer of green liquor, white liquor, and weak wash.

PERSONNEL

Another phase of the recovery cycle is the use and control of personnel. One cannot think constructively about the personnel requirements of the liquor cycle without taking into consideration the arrangement of the equipment. In order to stabilize the labor cost, not only in the liquor cycle but in all of the operating departments, it has been necessary to give serious thought to the placement of equipment in order to minimize the working areas. The wide variance of labor cost for liquor cycle operation between mills making the same product, in the same way with identical equipment, is not usually a varying degree of responsibility, but tied directly to the layout of the operating units. For instance, widely separated recovery furnaces may require an operator for each, while several units arranged so that their operating areas are adjacent or overlapping would permit efficient control with less men.

Most mills require an evaporator operator, but some of the newer mills have so placed this equipment that these duties are taken over by the recovery operators and helpers. It is not suggested that the evaporators will operate continuously and efficiently without the attention of trained personnel, but the job is one which does not require constant attendence. It is, therefore, possible to locate the equipment and control panels of instruments to make it an integral part of the recovery operation. With both the evaporator and recovery process under the direction of one operator, it is conceivable that the combined efficiency of the two units would be better. This arrangement might not mean a reduction in personnel but could result in lower operating cost due to differential wage rates.

This same type of thinking can be expanded to include recovery room operation, caustic house control, and lime burning practices. It is the direct responsibility of the pulp mill engineer to place sufficient emphasis on operating requirements when he develops designs for new mills or additions to old ones. There is little a liquor cycle supervisor can do in reducing man-hours if the operating areas are scattered and inaccessible.

Before leaving this subject of personnel, a few words on training would be appropriate. A mill can have the most modern and efficient equipment available and yet be unsuccessful from an operating standpoint if the personnel assigned to these jobs are poorly trained. It is inconceivable that anyone would turn over a new car to a young son before he had been properly trained to drive it. Yet at the same time, you as supervisors know well that you have turned over to your operators new equipment without first training them thoroughly in its use. The author does not know why we are so lax in this phase of our responsibilities. We expect a new man with little or no training to instantly absorb all of the complexities of the operation of industrial equipment, or we throw new and improved equipment into the operation without putting too much thought as to whether the present personnel are thoroughly instructed in the changes in design and controls. The only way in which top performance can be realized is through thorough training of the operating personnel.

OPERATION AND CONTROLS

The only reason for which a liquor cycle exists is for the recovery of the spent chemicals and their conversion into active cooking liquors. The liquor cycle equipment, its arrangement, and the personnel to operate it have been discussed at some length. It is not until these phases of the problem are reconciled with uniform operation through adequate manual and automatic controls that the liquor cycle is a profitable enterprise. All are too familar with this phase of kraft pulping to spend much time detailing it. However, the author would like to point out some of the more important factors which lead to an efficient and controlled operation. For instance, feed liquor concentrations must be uniform and as high as possible if the multiple effect evaporators are to further concentrate the black liquors sufficiently to permit economical recovery furnace operation. The relationship between feed liquor concentrations and wash room soda losses is well known. Perhaps one of the greatest lifts to over-all liquor cycle efficiencies within the past few years has been the development of brown stock washing equipment capable of delivering black liquor to the liquor cycle having high concentration of solids while delivering stock to the screen room substantially free of soda. The higher concentrations of black liquor solids in the feed liquor to the evaporators have meant lower steam cost for evaporation by increasing the efficiencies to as much as $4^1/_2$ and 5 lb. of water evaporated per pound of steam for some of the newer installations. This is a real gain over the experience of a few years ago when 2 to 3 lb. of water per pound of steam was considered good.

Modern recovery units are designed to handle liquors having concentrations as high as 65 to 70% solids. The use of highly concentrated liquors, dust precipitators, and contact heat exchangers, has made these units extremely efficient. Salt cake consumption has been lowered and steam generation improved appreciably. Continuity of operation for recovery furnaces has been made possible with the development of retractable soot blowers and air puff systems. The generation of $4^1/_2$ lb. of steam per pound of black liquor solids is common in

most mills today. Salt cake make-up has been reduced to almost unbelievable amounts by completely closing the black liquor system and by maintaining high reductions in the recovery furnaces. Some mills are reporting reductions in the neighborhood of 97%, although most mills are in the 92 to 94% range. A high reduction of sodium sulphate to sodium sulphide is very advantageous in the liquor cycle as it lessens the load of unreduced chemicals and reduces the volume of this material to be handled.

Although it is helpful to all continuous systems to have uniform flows, it is most beneficial during the causticizing process to have constant strength green liquor. The complete clarification of green liquor, as well as the complete removal of soda compounds from the green liquor dregs, is a must if optimum conversion of green to white liquor is to be expected. Soda losses can be reduced materially if sufficient attention is given to this operation. It is surprising to find that poor dregs washing will increase salt cake consumption as much a 30 to 40 lb. per ton of pulp. Any material lost at this point in the system is particularly costly, as the material has already been reduced and merely has to be converted to active chemical to be available as white liquor for cooking.

The conversion efficiencies of green liquor to white have been the subject of many discussions. As this is one of those reactions that never goes to completion, a compromise is necessary between the degree of conversion and the unfavorable conditions which accompany the maximum point. It is generally understood that lower concentrations will permit a more complete reaction, as well as the overtreatment with lime. However, the lower concentrations place an extra heavy load on the multiple effect evaporators and greater steam usage is to be expected. By overliming at the causticizers, the calcium carbonate sludge from the white liquor clarifiers contains too much free lime for efficient calcining in the lime kilns. Each mill must work out this balance to suit the conditions under which it operates. If sufficient evaporator capacity is available, it is well to run at a lower concentration. If lime kiln operations can be made efficient with higher concentrations of free soda, then overliming is permissible. It is a real challenge to the liquor cycle operators to develop information which establishes the conditions by which an efficient balance is realized.

It is amazing to note the wide variations which exist in lime kiln operation from mill to mill. Some of these variations are undoubtedly due to the size kilns, the nature of the fuel, and the chemistry of the lime mud. A review of existing information would indicate that while some mills have been able to reduce their fuel demand as low as $7^1/_2$ million B.t.u.'s per ton of lime, other mills are using as much as 18 million B.t.u.'s per ton of lime. To be sure the lower fuel consumptions are found in the mills having 300 to 350-ft. kilns, but for the shorter kilns a variation of 25% in fuel demand is not unusual. Mud dryness has some effect on these variations of fuel consumption, but kiln design and methods of operation are partly responsible. Perhaps no other piece of equipment in the liquor cycle suffers as much as a lime kiln which is inadequate to do the job. Overtaxing the capacity of a kiln means higher internal temperatures, poor reduction, and higher maintenance. Inefficiencies in lime burning are additive in that, stack losses go up, increasing new lime usage and fuel oil consumption, and are usually accompanied by a drop in availability of the reburned lime. The lower availability of the reburned lime plus the increased usage of new lime comes back to throw even more burden on the already overtaxed unit. The problem is one without a ready answer. Lime burning equipment is expensive and the sizes are such that small units are not economical to operate. Therefore, management must choose between inefficient operation or overcapitalization, where the capacities of the present equipment have been exceeded, less than that required to justify the purchase of a new kiln. To some extent, the recent development of flash drying equipment for the mud feed has answered this problem, but the capital requirements for this equipment are not easy to reconcile through increased efficiencies.

Automatic controls, technical and operating data, and analytical determinations are all important to efficient liquor cycle operation. More automatic controls are desperately needed in most phases of the operation. Great gains over a relatively short period have been made in the measurement and control of concentrated black liquor flows. However, at best, these controls are not too dependable and much of the operator's time is required to check and double-check the levels and flows. This is an extremely difficult problem as the nature of the material does not lend itself readily to most instrumentation already developed. Not only are the heavy black liquors extremely viscous and dense but the more fluid green and white liquors are very corrosive and often contain varying amounts of suspended solids.

The technical service department must provide prompt service to aid the operators for optimum control of the various processes. It is not a process in which the operator can judge his actions by visual observations. Analytical determinations must be made to correctly establish the reduction and conversion of the various chemicals.

MAINTENANCE

Before closing, this discussion of liquor cycle operations would not be complete without a word concerning maintenance. There are no gimmicks or tricky solutions to the maintenance problem. It can be controlled only by checking each piece of equipment thoroughly, whenever possible, and at times when past experience has indicated that failures are imminent. A comprehensive program of preventative maintenance will minimize down time and prevent unscheduled interruptions. It is only through a planned maintenance program that continuous operation can be effected. The cost of the maintenance of liquor cycle equipment is quite substantial, but the improvements in equipment design and materials of construction have been most beneficial. Shortages of stainless steel and other alloys during the war years, and immediately following, made the job of maintaining the liquor cycle equipment a tough one. However, an easing of this situation has provided maintenance materials, and thus has cut into maintenance down time and lowered its cost. When still better materials are available for conveying and processing the various liquors involved, the maintenance bill for the liquor cycle can be reduced still further.

SUMMARY

In summarizing the liquor cycle operation, the author would like to indicate the following points:

1. The basic principles of liquor cycle operation are well defined and with slight variations, the process is the same for the entire kraft industry.
2. The selection of equipment is governed by balancing efficient operation and low maintenance against the availability of capital and the cost of depreciation.
3. The physical location of the various units must be given serious consideration as continuity of operation is a function of communications between operators and the availability of the control centers to them.
4. Personnel requirements can be minimized by intelligent engineering in locating the operating areas in such a manner that all operators are fully employed.
5. The key to successful operation is trained personnel.
6. The conversion of spent black liquors into active cooking chemicals is strictly a chemical process and must be supported by up-to-the-minute technical data, if the operation is to be a successful one.
7. Constant flows and uniform concentrations of black, green, and white liquors can be maintained only if reliable recording and controlling instruments are suitably located, adequately maintained, and fully used by the operators.

8. Steady and continuous operation is only possible by a planned maintenance program.

For those who have been in liquor cycle work for longer than they like to remember, it should be said that there is little to compare in today's operation with that of only a few years ago. Today, the process is continuous, while yesterday it was mostly batch. Today, equipment design is far better than it has ever been before, as is proved conclusively by the levels of performance. Today, the consolidation of the many units makes for lower operating cost and less personnel. Today, the over-all operation is simpler, even though the operating requirements are more exacting. Many of the maintenance problems common to yesteryear are a thing of the past today. Today, the operator can occasionally catch his breath, while yesterday if he had done so, he probably would have been asphyxiated.

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Facts Versus Opinions

W. R. PURCELL

From a broad viewpoint, the science and art of quality control is an essential element of successful manufacturing, and, as such, is as old as manufacturing itself. Yet it is only recently emerging as a separate profession. The American Society for Quality Control, just over 7 years old, is now composed of 64 sections throughout the United States and Canada with a combined membership of over 6000.

Why has an old science and art become a new profession? Most quality control engineers of my acquaintance would agree with me if I said it is because of the application of statistics to the age-old problems of quality control. They would also agree with me if I said that the use of statistics means the replacement of opinions with facts, of intuition with logic. Quality control is not new. The application of facts and logic to quality control is new. Statistical quality control is a growing profession because it uses facts and logic to answer some of the old quality control questions. Among these old quality control questions are:

1. From the standpoint of producing a uniform product, is the process in need of adjustment?
2. If the process is in need of adjustment, how can we be sure to adjust: (a) the right thing, (b) in the right direction, (c) the right amount, and (d) at the right time?

The first step in the application of logic to these questions is to answer two preliminary questions:

1. From the standpoint of producing a uniform product, how well can the process do?
2. Is it doing as well as it can?

To answer these questions statistical quality control does not ask persons for opinions, it asks the process for facts.

If the process says it is doing as well as it can, statistical quality control says: "leave it alone."

If the process says it is not doing as well as it can, statistical quality control steps in and provides the operator with improved tools to help him to know: (1) what degree of uniformity is expected; (2) how well his process is meeting expected limits; and (3) what to adjust, in what direction, how far, at what time.

In addition, statistical quality control provides a running scoreboard to record performance. The scoreboard provides factual information by means of which the operator improves his knowledge of how the process is responding to his adjustments, and over a period of time he thus improves his adjusting technique.

But quality control is not quite as simple as all that. While the application of factual information in convenient form as a running scoreboard usually improves the operator's skill in adjusting, there are some stubborn processes which still fail to do as well as they can. For the relations between cause and effect are often not simple. Sometimes an effect is so entangled with a whole myriad of causes and possible causes that the problem cannot be solved at the shop level.

This is not surprising when it is realized, for instance, that the composition and texture of wood vary from forest to forest, between different parts of the same forest, from year to year, from season to season, from species to species, from tree to tree, and between different parts of the same tree. This variation is caused by a tremendous multitude of factors which themselves depend on weather conditions and other natural forces which act in an endless procession of variability. Trees are harvested by variable men and the logs are shipped to mills to be processed into pulp and paper. The processing is done by persons, and persons themselves vary among one another in age, sex, aptitude, skill, temperament, etc., and each individual person varies in many of these characteristics from year to year, from day to day, even from hour to hour. In doing the processing, these variable persons, starting with variable raw materials, use equipment which has been designed by variable persons and built by other variable persons out of other variable raw materials. The finished product is inspected by variable persons using equipment designed and constructed out of variable materials by other variable persons. Finally the finished product is used by other variable persons, and if the customer is himself a manufacturer, is again subject to the long chain of complex variability.

Fortunately the experience of the operator has been remarkably successful in coping with this problem of variability. From experience come valuable fingertip facts for controlling a process.

Yet experience, valuable as it is up to a point, can hamper progress if it fails to distinguish between well-established facts and hunches. For the myriad of variable causes which exist in a process have a perverse habit of producing facts from which wrong causes can easily be deduced. If a process is not doing as well as it can, that is itself evidence that experience alone has not been able to cope fully with the complex problem of variability.

At this point statistical quality control steps in again with special techniques for correlating cause and effect, and for separating those effects which are due to a small number of dominant causes from those which are due to a large number of very small causes. It is here, more than at any other point, that statistical quality control must insist on facts told by the process instead of opinions expressed by persons.

By facts is meant data from well-conducted experiments, extensive data carefully taken and recorded during processing, etc. Opinions, on the other hand, are often stated as if they were well-established facts, and take forms such as:

"You can't improve on that, we've tried for years."

"I know just what causes that!"

"The trouble can't be in the drier, we hold everything constant there."

"We've known for years that eating fish is good for the brain."

"All the trouble is in the materials we get."

The seasoned quality control engineer never completely accepts such statements without supporting evidence in the form of data. If no supporting evidence is available, he might still use such statements as guides in his efforts, but with the mental reservation that their validity should be checked further before his program of improvement is terminated.

As a conclusion to this paper, one fact and one opinion stand out. The fact: the use of statistics in quality control has resulted in higher quality and lower cost in many fields of manufacturing. The opinion: the use of statistics in the pulp and paper industry will also result in higher quality and lower cost.

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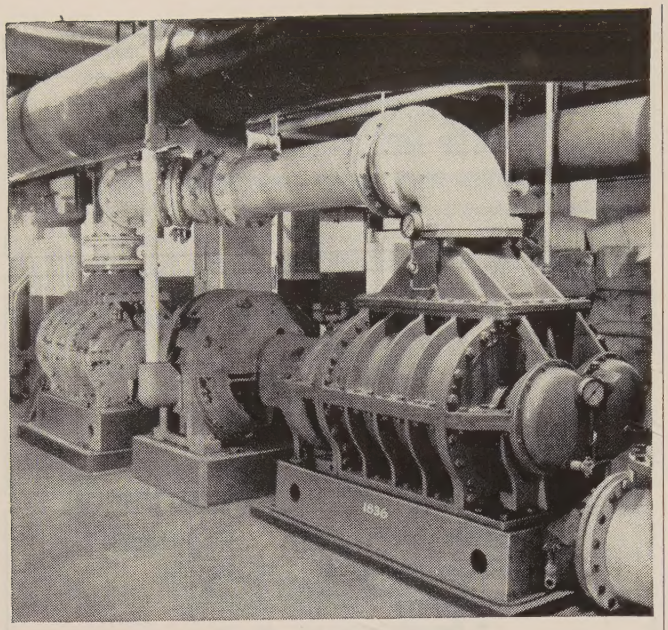
Tenth Fibrous Agricultural Residues Conference, Trenton, Ontario, October 8–9, 1953.

Third Corrugated Containers Conference, Statler Hotel, New York, N. Y., October 15–16, 1953.

Eighth Engineering Conference, Sheraton-Mt. Royal Hotel, Montreal, P. Q., October 26–29, 1953.

Seventh Alkaline Pulping Conference, Rice Hotel, Houston, Texas, November 18–20, 1953.

Thirty-ninth Annual Meeting, Commodore Hotel, New York, N. Y., February 15–18, 1954.



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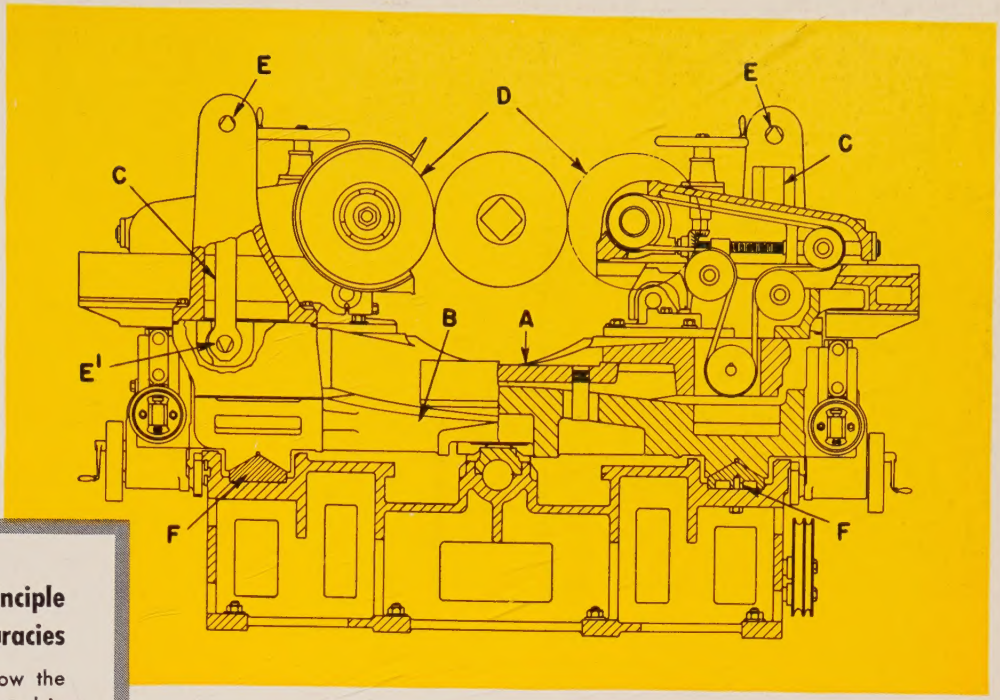

How the swing rest principle eliminates minor inaccuracies

The above diagram shows how the two grinding wheels are mounted in a Farrel swing-rest roll grinder.

The saddle "A" is swung by links "C" on knife edges "E" and "E'" from brackets supported on carriage "B". The grinding wheels "D" are mounted on the saddle.

Any movement of the carriage "B" imparted by inaccuracies in the ways "F" will cause a corresponding sidewise movement of the saddle supports. If the grinder were operated as a fixed-wheel machine, this would also cause an equal sidewise movement of the grinding wheels.

But in the Farrel swing-rest machine, instead of following the path of the ways, the grinding wheels follow a line parallel with the axis of the roll. Hence, the error transmitted to the roll is reduced correspondingly.

"Swing-rest" gives that EXTRA ACCURACY you need in grinding Calender Rolls

The swing-rest feature of the Farrel two-wheel roll grinder was designed to provide a greater degree of accuracy in grinding long rolls than is possible with a fixed-wheel machine.

This exclusive method of mounting the wheels offsets minor errors due to the ways being out of parallel with each other or with the axis of the roll, caused by distortions in the machine bed from seasoning, temperature changes, settling of foundation, etc. Because the swing rest eliminates the effect on roll accuracy of such conditions, the machine, when accurately set, will grind rolls to the proper straightness or uniformity of curvature, and to exact roundness.

Send for a copy of Bulletin 118, which describes in detail the many advantages of the Farrel two-wheel, swing-rest roll grinder. No cost or obligation.

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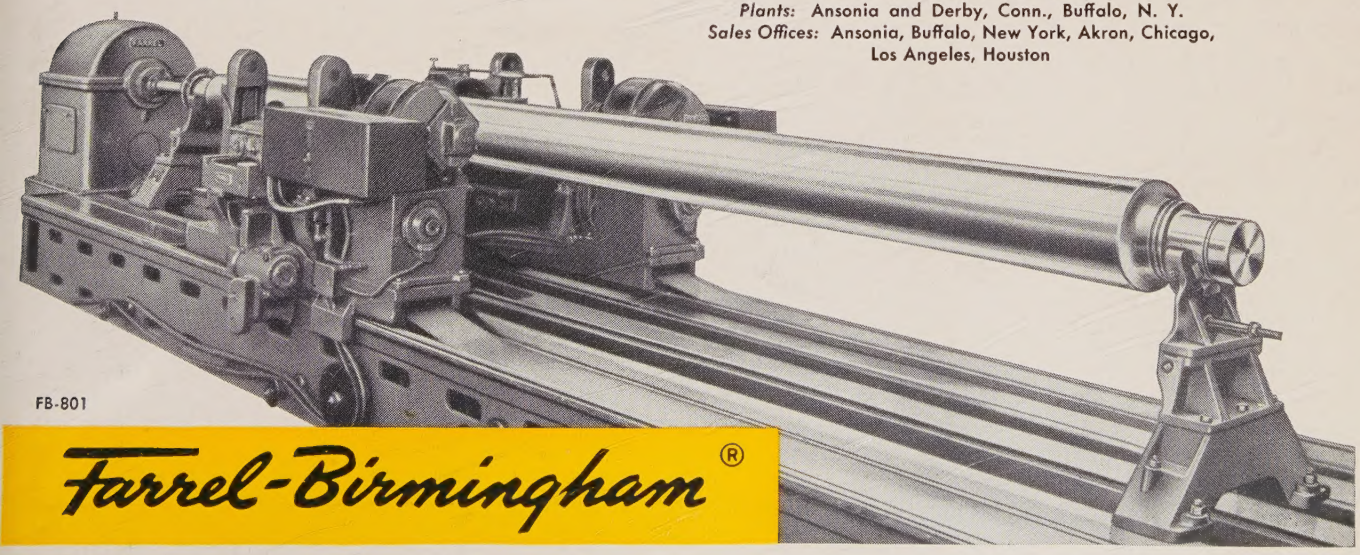

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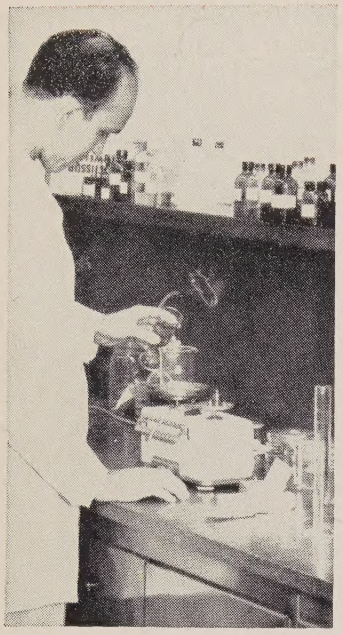

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